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VOL. 40, No. 3, 1957.

THE MALAYAN AGRICULTURAL JOURNAL

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Kuala Lumpur.
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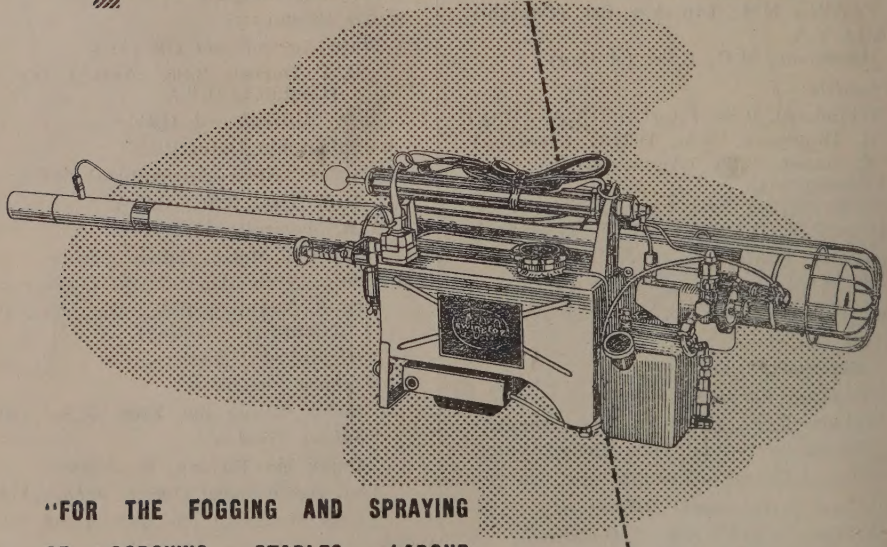

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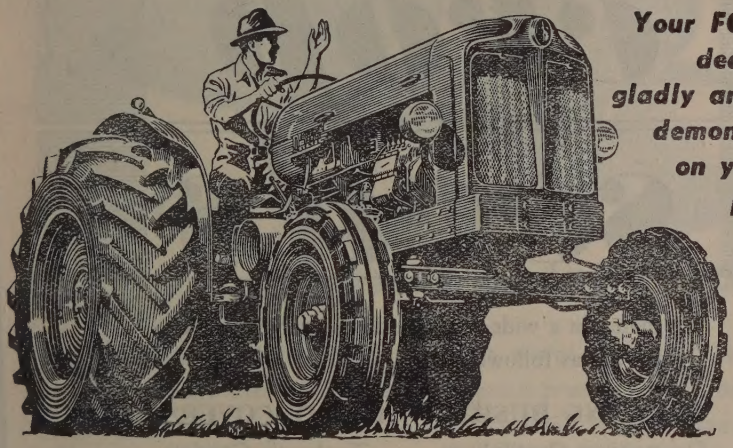

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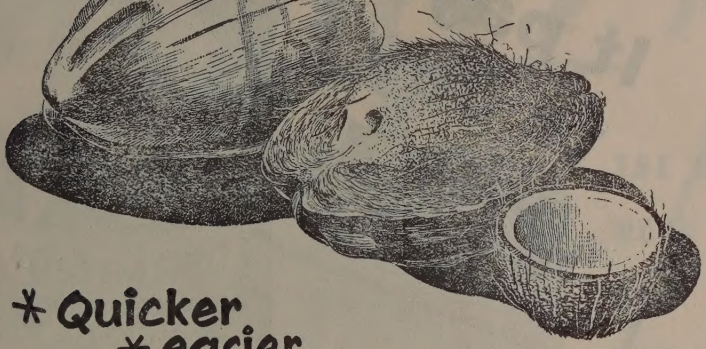

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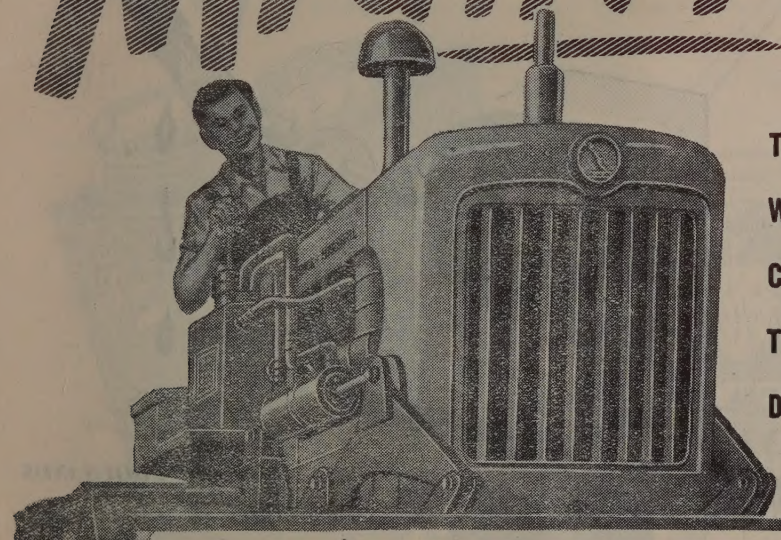

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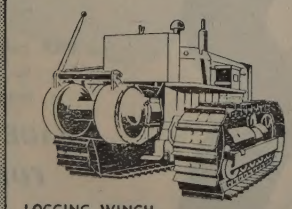

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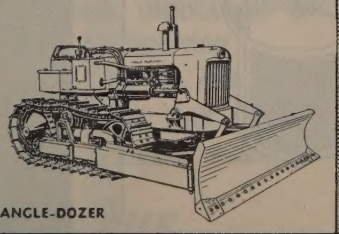

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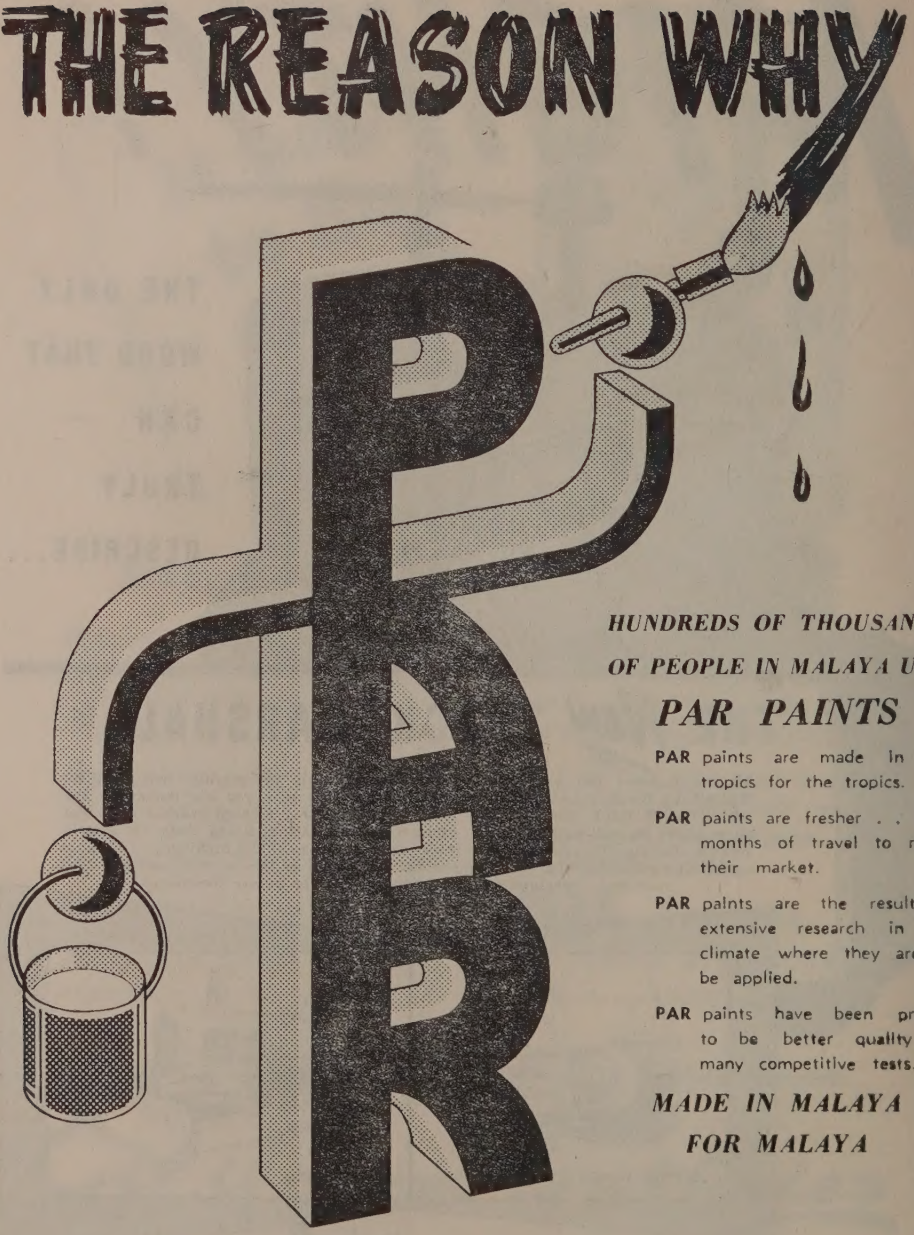

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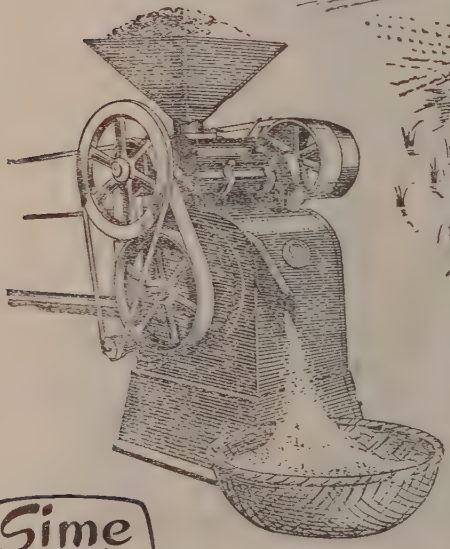

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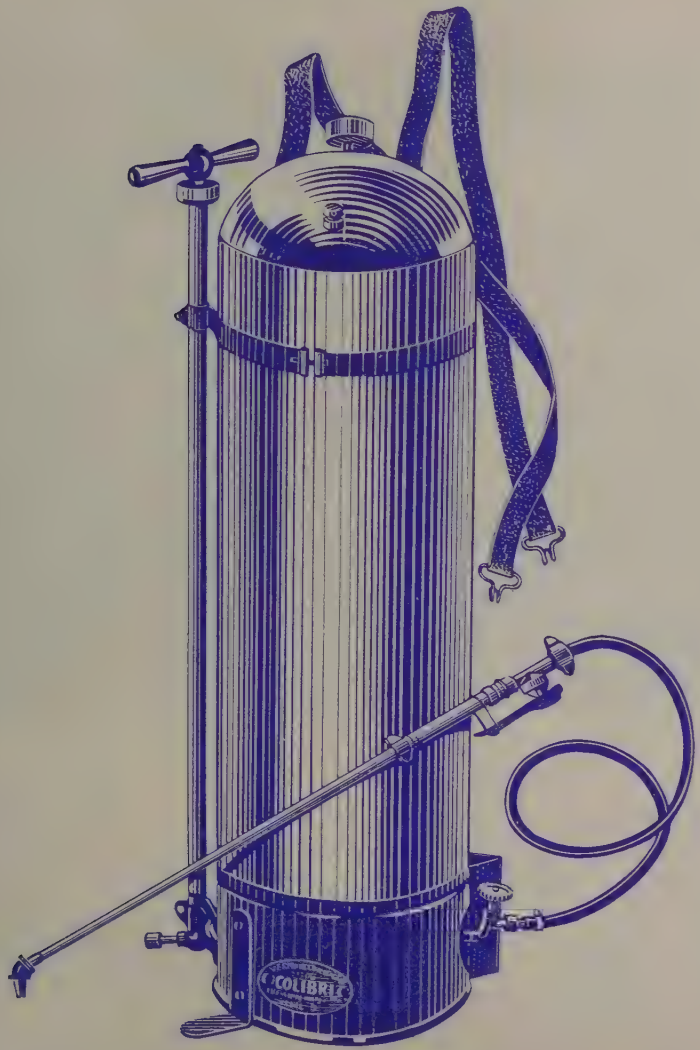

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THE

Malayan Agricultural Journal

Edited by the Publications Officer with the Assistance of The Publications Committee.

Vol. 40, No. 3. **1957**

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The Journal, which is published quarterly, is designed to present — as far as possible in non-technical terms — the results of the agricultural research, investigation and extention work performed by the Department of Agriculture and it draws attention to the results of work of a similar nature in other countries.

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THE

Malayan Agricultural Journal

Vol. 40, No. 3, 1957.

EDITORIAL

Malaya's Pineapples. The pineapple, a native of South America, was spread round the world by ships of the Spanish and Portugese navies *. It has been cultivated in Malaya for at least four centuries; during this time it has been grown not only as a dessert fruit, but for a number of other products. Perhaps the most important of these were the tough fibres of the leaves, which two centuries ago were widely used as sewing thread and until cotton became readily available were utilised for fishing lines and nets which were particularly durable in salt water. Long-leaved types not so suitable for fruit production were used for fibre making.

The juice of the unripe fruit has been widely used as a medicant by both Malays and Chinese. It is recorded that in the early 1800s the juice was used by Malays in etching the blade of a kris. Attempts have been made to ferment it into wine, but the resulting liquor was not a great success and eventually proved, after further fermentation, to be most useful as a coagulant for rubber.

The pineapple canning industry was started before 1886, for in that year an exhibit of tinned fruit was sent to the Colonial and Indian Exhibition from a factory in Singapore. The first big expansion of the crop in the Federation took place about 1920 when the acreage under rubber in Johore expanded rapidly and pineapples were planted widely as a catch crop. The modern industry is still concentrated in that State, which has two-thirds of the country's pineapple acreage.

Malaya is fortunate in that her soil is especially suitable for pineapple production. This country's golden fruit, once thought to be a fit present for a king, is today a universal favourite.

Development of the Peat Soils of Malaya. Amid the clamour for speedy and wide-spread alienation of new land, it might be well to remember the words of Vageler †, who wrote nearly twenty-

* The history of the pineapple is fully described in *A Dictionary of The Economic Products of The Malayan Peninsula*, by I.H. Burkill, from which these notes were drawn.

† *An Introduction to Tropical Soils*, by Dr. P. Vageler.

five years ago that if the causes of failure of agricultural undertakings in the tropics are critically examined, well over 75 percent are found to be mainly, if not entirely, due to the wrong choice of land. Evaluation of the potential productively of tropical soils is a most difficult task and one which often entails long and expensive research and investigation.

Today about 20% of Malaya's land surface is under cultivation. Another 30-35% is estimated to be too steep for agriculture. The best promise of new land for cultivation, especially for padi land, has been thought to be the 12-15% which is flat land still under jungle. It is with part of this area, the peat-covered land, that Mr. Coulter deals in his article in this issue of the *Malayan Agricultural Journal*. He discusses the present knowledge of peat cropping and improvement of peat soils and sums up the work done by the Department of Agriculture, which has for a number of years had an experiment station established on this soil. It is plain that full utilisation of Malaya's peat soils must come slowly; but certain crops, e.g. pineapples, can be grown on peat if the correct cultural practices are employed. It is essential that the basic information on how best to use peat soils be made available to those guiding the country's land development before any large-scale alienation takes place. For neither the country nor the farmer, who may spend four years of hard labour clearing the jungle from a six-acre lot, can afford the consequences of a mistake.

Delay in Publication. The late issue of the *Malayan Agricultural Journal* is regretted but is beyond the control of the publishers.

THE PINEAPPLE IN MALAYA

(*Ananas comosus* Merr.)

BY

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Introduction

The Malayan pineapple industry was founded before the turn of the century. In the early days it was closely associated with the rubber industry, the pineapples being planted in the inter-rows of young rubber. Later it was planted as a sole crop on upland (quartzite) soils. The useful life of a pineapple plantation on these soils was five to six years, due partly to soil exhaustion but mainly to soil erosion. In 1938 a move began to transfer the cultivation of pineapple to the deep peat soils and, following its virtual destruction during the Japanese occupation of Malaya, the industry is now developing almost exclusively on these soils.

The greater part of the industry is now in West Johore where there are 12,000 acres of estates and 8,000 acres of smallholdings; in Selangor there is one estate and 3,200 acres of smallholdings and in Perak, one estate and 400 acres of smallholdings. At the end of 1956 the total area planted with pineapples in the Federation of Malaya was about 44,800 acres. Exports of canned pineapples and canned pineapple juice from the Federation and Singapore in 1956 were valued at $31,670,000. Nearly all the fruit processed by Singapore canneries was grown in the Federation.

Description of the Plant

The cultivated pineapple is a monocotyledon, a member of the family *Bromeliaceae*. This family also includes a number of epiphytes. In the genus *Ananas* there are three wild species, which are found in South America, but no wild ancestral form of the cultivated pineapple, *Ananas comosus* Merr., is known. The cultivated varieties are self-incompatible and therefore usually seedless.

In the early stages of growth the pineapple grows vegetatively, producing leaves and building up a store of starch in the central axis. Later, by differentiation of the growing point, a large number of flowers are formed which in turn produce the individual berry-like fruitlets; these, together, compose the pineapple. On the death of the flowers, the peduncle which extends through the middle of the fruit (the "core") produces further vegetative growth on the top of the fruit; this growth is known as the "crown". As the fruit develops there is further vegetative growth of the mother plant, producing the materials by which the plant is further propagated. Four main types of this planting material

(see Fig. I) are available and they are described in the paragraphs which follow.

Crowns

The crown is produced on the top of the developing fruit. A single crown is desirable but fasciated and multiple crowns are common. The crown is seldom used for propagation in Malaya as it is, by its very nature, limited in supply and it is also slow to come to maturity; it should not be planted mixed with other forms of propagating material. It is a widespread practice in Malaya to remove the crown when it is a few inches high. Crown slips, which develop beside the crown, are not common in Malaya.

Basal Slips

Basal slips produced on the stem just below the fruit are the principal planting material for the Singapore Spanish and Selangor Green varieties. They are, however, seldom produced by the Sarawak and Mauritius varieties. The slips are collected soon after the harvest of the fruit; their subsequent treatment is described later.

Aerial and Ground Suckers

It is the aerial suckers, produced in the axils of the leaves on the main stem, and the ground suckers from the base of the mother plant which produce the ratoon crop when left *in situ*. They can also be used as planting materials.

The stage of growth of the suckers at the time of harvest of the mother plant varies between varieties. Of the varieties in Malaya, suckers of Singapore Spanish are often well grown at the time of harvest, but with Sarawak, few—if any—suckers are present and these are small.

Pineapple Varieties in Malaya

The bulk of the pineapple crop in Malaya is canned and the canning industry uses almost exclusively the Singapore Spanish variety and its mutant, the Selangor Green. For the fresh fruit market two varieties are grown—the Sarawak and the Mauritius. *Ananas cochinchinensis* (Malay: *'Nanas Bunga'*) is found in many kampongs, but it is an ornamental only (1).

Singapore Spanish Variety [Singapore Canning, Singapore Queen and Red Jamaica (Malay: *Nanas Merah*)]

The Singapore Spanish is the principal canning variety grown in Malaya. The mature plant is of medium size, carrying up to 50 leaves. In the healthy plant, these leaves are dark green and glabrous above, often with a reddish stripe along the edge, and are often glaucous beneath. The leaves carry very few spines; if present the spines are

usually found near the distal end. At harvest time the mother plant may have two or three ground suckers and two or three aerial suckers. Fasciated and multiple crowns are common, although single crowns are more desirable.

The fruit usually weighs from 2 to 4 lb. and is a satisfactory shape. The colour of the flesh is good—a golden yellow. If the proper fertilisers have been used and the fruit is ripe when picked, the flesh is sweet and juicy though sometimes slightly fibrous. The 'eyes' are deep and irregular but the core is of reasonable size.

THE GREEN SELANGOR [SELANGOR GREEN, SELASSIE AND GREEN SPANISH (MALAY: *Nanas Hijau*)]

The Green Selangor is very similar to the Singapore Spanish, of which it is probably a mutant. Its leaves, however, are more yellow-green in colour and are not able to produce the red pigment. Under unfavourable conditions they turn a lighter yellow-green and in severe cases may turn almost white. The leaves usually have a few spines near the tip.

The green fruit turns to a golden yellow when ripe. The flesh colour is good but is sometimes spoilt by white flecks. The 'eyes' are not as deep as those in the Singapore Spanish.

THE SARAWAK VARIETY [SMOOTH CAYENNE AND KEW (MALAY: *Nanas Sarawak*)]

The Sarawak is a larger and more vigorous plant than the other varieties grown in Malaya. Planted at low populations it tends to continue vegetative growth for a long time and is slow to come into flower. The leaves are a deeper green than those of the Singapore Spanish variety and the reddening which is in the centre of the leaf is more prominent. The leaves occasionally bear some spines near the tip. One type has a tree-like habit of growth with a thick stem 5 to 6 ft. in height and bears short, pliant, curved leaves. If a fruit is borne on this type it may be up to 25 lb. in weight.

The fruit is much larger (4 to 6 lb.) than that of Singapore Spanish and is often of poor, conical shape. The flesh colour is a pale yellow; fully ripe fruits are of good quality except for an occasional tendency to be fibrous. The core is large. The fruit is sold mainly for the fresh fruit market.

At the time of harvest few suckers are present; they develop in the following two months. Few plants produce basal slips.

THE MAURITIUS VARIETY [MALACCA QUEEN, RED CEYLON AND RED MALACCA (MALAY: *Nanas Moris* AND *Nanas Europah*)]

The Mauritius is the smallest of the Malayan varieties and is grown almost exclusively for dessert purposes.

The leaves are darker green than those of the other varieties and

they have a broad, central red stripe. The leaf edges are lined with red spines.

The fruit is small, usually 2 to 3 lb. The flesh colour is good and the core small, but the 'eyes' are deep. Quality is very variable.

Suckers are often produced in excessive numbers following the harvest of the mother plant. Basal slips are rare.

Undesirable Characters in the Plant

Plants showing undesirable characters are quite common and growers are advised to rogue their plantations carefully. The planting materials (crowns, slips and suckers) from plants showing the following characters should be destroyed.

MULTIPLE CROWN (MALAY: *Jambul Ber-chabang Banyak*)

Two, three or more separate crowns are produced (Fig. II) on one fruit. This condition should be distinguished from "fasciated crown" (Malay: *sisir ganjil*) where one enlarged crown is formed (Fig. III). Fasciation may be a result of environment.

COLLAR OF SLIPS (MALAY: *Buah Ber-tunas*)

Basal slips are normally found on the peduncle, just below the fruit, but in the condition "collar of slips" they are found fused to the base of the fruit itself (Fig. IV).

BOTTLE-NECK FRUIT (MALAY: *Buah Tergenchat*)

In this condition the lower half of the fruit develops normally, but the upper half remains undeveloped and dry, consisting only of swollen bracts and a core (Fig. V).

"FUSED FRUITS" (FASCIATED FRUIT) (MALAY: *Buah Ber-kedua*)

A malformed fruit body appears as two partially fused fruit with a common base, but usually with distinct shoulders and crowns (Fig. VI). This is more common in the Sarawak variety.

DRY FRUIT (MALAY: *Buah Kempis*)

The fruit fails to develop normally and consists only of swollen bracts and a core, like the upper part of a "bottle-neck" fruit.

CANNON BALL FRUIT (MALAY: *Buah Bulat*)

As a result of the failure of the apical florets to develop, a small, round fruit is formed.

SLENDER FRUIT (MALAY: *Buah Bujor*)

A long, narrow fruit develops on which the bracts appear unusually long (Fig. VII).

SPINY LEAVES (MALAY: *Daun Ber-duri*)

Singapore Spanish and Selangor Green plants normally carry only a few spines on the leaf-edge; those bearing many spines (Fig. VIII) should be eradicated.

MANY FINE LEAVES (MALAY: *Puchok Menyerai*)

Little or no fruit is produced but a large number of very fine leaves appear (Fig. IX).

Desirable Characters in the Plant

In addition to removing plants with undesirable characters, growers can search for plants with the following good characters which make them especially suitable for propagation:—

(i) Vigorous, normal growth;
(ii) Good propagating material (normal crowns, six to eight slips, two to three suckers);
(iii) Disease resistance;
(iv) Uniformity; and
(v) Fruits having:—
  (a) "Eyes" as shallow as possible;
  (b) Diameter of 4 to 5 in.;
  (c) Rectangular or slightly oval shape;
  (d) Fruits as long as possible within the limits of (b) and (c);
  (e) A small core;
  (f) Good quality (this is partly heritable and partly environmental); and
  (g) A good colour and relative absence of air cells. It is not normally possible for the grower to be able to judge the characters (a), (e), (f) or (g).

Peat

It has been estimated that there are about one million acres covered by deep peat in Malaya. Most of this is in low-lying swamp deposits (bog-soils) and is found in West Johore, Selangor and Perak, with small areas in Kelantan, Trengganu and East Johore. The land now lies mainly under swamp jungle (3).

Smallholders have grown pineapples on these soils continuously for 40 to 50 years and, following a review of the situation in 1947, it was decided that in rebuilding the Malayan pineapple canning industry these soils should be used (4). Today all the major pineapple-producing areas are found on deep peat.

Peat is defined as an organic soil at least half a metre (19.69 in.) in depth, one hectare (2.471 acres) in extent and with a mineral matter content not exceeding 35 per cent. Such soils, except for small areas of upland peat, are usually found under conditions of forest lying in

waterlogged depressions. The thickness varies from a few feet to 18 ft. or more, though it may be traversed by sand dunes or clay belts of higher land laid down in times of flood by rivers which have subsequently changed course (5).

Much work remains to be done on the peat soils. However, early indications are that the peats of the various areas in Malaya are similar, having been developed under the same conditions. Up to 50 per cent of the peat may be composed of timber in varying stages of decay. Chemically, wide variations are found within an area though no consistent variation has yet been found between the different areas. The Malayan peats are all low in mineral matter content, especially calcium and potash. The soil acidity varies widely; pH values varying between 3.3 and 5.1 have been determined.

Preparation of Land

The land being alienated for pineapples today is principally swamp jungle lying on deep peat. In many areas the water level rises above the surface of the land during the wet season. The natural growth is luxuriant and is found in several storeys. The trees show great variation in size and several hundred species are present in addition to palms, climbers and shrubs. Among the more important plant species usually found are (Malay names in brackets) :—

Campnosperma spp. (*terentang*)
Cratoxylon arborescens (*geronggang*)
Xylopia fusca (*jangkang paya*)
Eugenia spp. (*kelat*)
Dillenia spp. (*simpoh*)
Tetramerista glabra (*punah*)
Calophyllum spp. (*bintangor*)
Koompassia malaccensis (*kempas*)
Palaquium obovatum (*nyatoh*)
Shorea spp. (*meranti*)
Gonystylus bancanus (*melawis*)

The first step in the usual method of clearing is to cut traces through the area. After that, all undergrowth is slashed and the trees are felled. When the branches have been cut off, the felled timber is left to dry for several months. When the timber is dry and the weather is suitable, the first burn is begun. Men enter the area and move slowly up-wind about three chains apart. At intervals, pieces of sacking saturated with paraffin are lighted and dropped to set fire to the brush. This is followed by a collection of the smaller limbs and a second, smaller burn in which the remaining timber up to a diameter of 4 to 6 in. (as specified by contract) is burned. The drainage system can be put in when convenient, but is usually not complete at the time of burning.

This method of clearing is cheap and quick but has grave disadvantages. All the tree stumps and the larger timbers are left *in situ*,

thereby reducing the amount of land available for planting and making all subsequent operations more difficult (see Plate I). A better burn, and therefore better clearing, would be obtained if the drains were put in at the time the traces are cut.

More thorough clearing has been practised on the stations of the Department of Agriculture—sufficient to permit some degree of mechanisation. Such clearing however requires a considerable increase in initial capital outlay.

Drainage is of fundamental importance and it is essential to ensure that it is satisfactory before planting begins. Badly drained soil will result in poor growth of the pineapple and excessive weeds. It is not possible to lay down any hard and fast rules, but on level land, where the outfall is suitable, drains 5 to 6 ft. deep at 10 chain intervals would be adequate. Where it is only possible to have drains 3 ft. deep, the spacing may have to be reduced to two chains. It should be realised that the more frequent the drains, the greater are the difficulties of working and the greater is the waste of land.

Previous to planting the land should be cleaned and levelled.

Ridging

Ridging is not normally practised. The simple pointed ridge, commonly used for other crops, is not suitable for pineapples as the roots of the pineapple become exposed and frequently the weight of the fruit pulls the plant over. The flat-topped ridge, capable of carrying two rows of pineapples, is sometimes used where adequate drainage is not otherwise obtainable.

Spacing

The traditional spacing giving an initial plant population of only 3,000 to 4,000 per acre (6) can no longer be regarded as satisfactory. Planting pineapples in double rows is now recommended. This permits an increase in the population with continued ease of working. Triple rows are not satisfactory because growth of the centre row tends to be poorer than that of the outer rows. Further, all subsequent operations on the middle row, such as weeding, the application of fertilisers and hormones, harvesting and trimming, become more difficult and require more labour.

Paths between the double rows should be a minimum of 4 ft. wide (Fig. X). When they are narrower than 4 ft. they become overgrown and the difficulty of working the area is increased. Slashing of the leaves of the pineapple plants to clear such paths is undesirable as it results in fruit of poor size.

With the Singapore Spanish variety, a spacing within the rows of 2 x 2 ft. is suitable and will give an initial population of 7,250 plants per acre. This spacing can be recommended to smallholders who are short of planting material or lack the capital to buy the extra planting material and fertilisers required for higher populations. There is

evidence to show that a further increase in initial population up to 14,000 plants per acre will result in greatly increased early yields. The tendency then for a decrease in the size of the individual fruit could probably be off-set by the correct use of fertilisers.

It appears to be essential to plant material of the Sarawak variety at the closer spacing (double rows planted 2 x 1 ft. with a 4 ft. path). Planted at lower densities this variety tends to develop excessive vegetative growth, is very slow and uneven when coming to flower and produces fruits of excessive size which frequently fall over and are affected by sunburn. Close spacing and the use of flowering control substances are therefore recommended.

Paths

Unless drains or roads make them unnecessary, harvesting paths should be left at intervals of 10 chains. Paths 6 ft. wide are adequate.

Preparation of Planting Materials

Following the harvesting of the fruit, the basal slips will continue to grow on the peduncle and can be collected when convenient and brought to some central position.

Slips and other planting material of plants showing the undesirable characters previously mentioned should be removed and chopped up. Slips less than 8 to 9 in. long should also be discarded. The remaining slips can be graded according to size, so that in any one area only one type of planting material, all of the same size, is planted. The slips can be further graded according to their circumference at the base.

Removal of the small scale leaves at the base of the slips and trimming of the base with a knife will probably accelerate the establishment of the crop but are not essential. Care must be taken that the material is not damaged. When adequate skilled labour is available it may be found economic to carry out these operations.

All slips must be dipped in Bordeaux (copper-lime) mixture (Plate IIa). Any suitable container, such as an oil drum, may be used for the mixture, but it will rust iron or steel; if a vessel is to be specially made, it should be made of wood or brass. A suitable mixture is 1 lb. copper sulphate, 1 lb. quick lime and 10 gallons of water. Ready-slaked lime, however, is frequently used. The copper sulphate should be ground and a concentrated solution of it prepared. This is added slowly to the dilute suspension of lime. The slips should be dipped right into the mixture so that it enters the heart and the leaf axils. The slips are withdrawn and inverted for a moment until the solution has drained off. Then the slips are stacked on dry ground, butts uppermost, in *single* layers and dried in the sun for two or three days (Plate II b). This operation is essential. The slips are then ready for planting, but if not required can be stored thus without cover for four to six months. For transport, the slips should be tied in bundles of fifty.

PLATE I

Newly planted area showing timber lie. Smallholding area near Pontian, Johore.

PLATE IIa

Preparation of planting material. The bundle of slips is about to be plunged into the copper-lime mixture so that the mixture enters the heart and leaf axils of each slip.

PLATE IIb

The slips are being sun-dried in an inverted position after dipping.

PLATE IIIa

Traditional method of planting. One man makes the holes along the marked wire while the second puts in the slips (already scattered along the line) and consolidates the soil round the slips with his feet. Note that the land is clean.

PLATE IIIb

Use of the Hawaiian tool in planting. As each slip is planted the soil around the one planted previously is consolidated with the feet. (The marking wire is not shown in the photograph). Note that the land is clean.

Suckers are not normally used as planting material except for the Sarawak and Mauritius varieties. They should be treated in the same way as slips but more size grades will be required because of the greater variability of suckers. The practice of trimming the leaves severely is undesirable, but light trimming may facilitate transport of the material. Larger suckers (over 2 ft. in length) are unsatisfactory because they tend to come straight into flower after planting and produce either small fruits or fruits with broken core disease.

Planting

The headlands of an area to be planted should be marked out first. The rows should be marked by the erection of poles, and if pieces of cloth or paper are fixed to the ends of these, sighting is made easier. Intermediate marking posts can then be added. Wire, marked at appropriate intervals (2 ft. or 1 ft.), is used to indicate to the planter where to put the individual plants.

The planting material, which will have been treated and graded as described earlier, is then dropped along the lines of the rows. The usual method of planting is for one man to move along the line of the rows making the planting holes with a pointed stick. He is followed by the planter, who puts the slips or suckers (previously dropped) into the holes and presses the soil firmly round the plant with his feet (Plate IIIa).

When planting, it is important to ensure that:—

(i) the holes are not made too deep. This may result in a hole being left beneath the base of the plant, which will consequently grow poorly;

(ii) the soil is pressed firmly round the base of the plant; and

(iii) no soil gets into the heart.

An adapation of a tool (Fig. XI) from Hawaii can also be used (Plate IIIb). This implement has a flat, slightly pointed steel blade which is 8 in. long, 1½ in. wide at the base and 2½ to 3 in. wide at the head. The blade is ¼ in. thick and has a handle 6 in. long. It is said that one man can plant 5,000 to 7,000 plants a day using this tool in Hawaii (2). Much lower figures have been obtained in Malaya, but if the soil is fairly well consolidated and there is little timber, this implement could speed up planting.

When using this implement, the planter plunges the blade into the soil at an angle and, by drawing the handle forward, makes a hole behind the blade into which he puts the slip. The blade is then withdrawn and the soil pressed round the plant with the feet as the next hole is being made. It is most tiring work.

Weeding

Following planting, the area must be kept clean-weeded. If weed growth is found to be excessive and includes such damp-loving plants

as *Fimbristylis* spp. (Malay: *misai-keli*) the drainage should be improved. As the pineapple is shallow-rooted, care must be taken when weeding around the plants not to remove the soil and expose the roots. Trials of controlling weeds with machines and by the use of herbicides have been carried out, but no economic recommendations can yet be made. Hand-weeding with a tajak is most suitable. Lalang (*Imperata cylindrica*) should not present any problem, but if it is found the roots should be pulled out, and for this an Assam fork is useful. Well grown pineapple plants at the recommended spacing should require little weeding after the first six to eight months.

Flowering Control

In Malaya, pineapples which are allowed to flower naturally will produce a major harvest during the period from May to July and a secondary harvest at the end of the year. In any one area the fruit will ripen over a period of two to three months. This results in considerable seasonal demand for labour and also means that for part of the year the canneries are over-worked and for much of the rest of the year they receive little fruit.

Chemicals can be applied to the plant to induce it to flower. Such substances, when applied in an area where planting material of even size has been used and where the growing plants have been brought along evenly, can be used to concentrate the harvest in that area over a period of a week or two. This obviates the necessity of having continually to send in labour for harvesting over a long period. These chemicals are applied in solution and such solutions can also help to level off the harvesting peaks. Trials on the delaying of maturation, which would also help to level the peaks and increase fruit size, are now in progress.

It is important when using these chemicals that only plants of sufficient size are treated, that is, healthy plants with about 35 leaves. Smaller plants can be induced to flower, but the resultant fruits are small, and few, if any, slips and suckers are produced.

The recommended treatments are set out below.

Alpha-Naphthaleneacetic Acid

The most widely used substance is alpha-naphthaleneacetic acid. This is sold in a number of forms under trade names such as Planofix (in solution form), Aperdex (in tablets) and Hortomone A (in powder form). The manufacturers' instructions should be followed to prepare a five or ten parts per million solution. Fifty cubic centimetres (50 c.c.) of this solution is then poured into the heart of the plant. The bottom of an ordinary cigarette tin, with a depth of $\frac{5}{8}$ in., will contain 50 c.c. (Fig. XI). It is important that the correct amount and strength of the solution be applied, for excess of either of these may delay flowering or cause distortion. One application of the solution is sufficient.

Treatment with alpha-naphthaleneacetic acid is recommended for the varieties Singapore Spanish, Selangor Green and Mauritius.

Calcium Carbide

Calcium carbide also can be used for control of flowering, but labour costs are greater than for alpha-naphthaleneacetic acid because two or three applications are required. There is some evidence, however, that treatment with calcium carbide is more suitable for the Sarawak variety. It may also be more convenient for smallholders to use on the other varieties.

The methods of applying calcium carbide are described in the paragraphs which follow.

Dry Method

A quantity of calcium carbide should be allowed to stand in the air for 24 hours and then be ground to a powder. A pinch of this powder taken between the finger and thumb is placed in the heart of each plant. The treatment is repeated after three days.

Wet Method

A stout vessel, such as a carboy or steel drum, should be two-thirds filled with water. Calcium carbide is added at a rate of 1 lb. per 12 to 16 gallons of water and the vessel is closed. Great care must be taken to ensure that the vessel has not been cracked or weakened and that the correct proportions of calcium carbide and water are used. If these precautions are not taken, there is danger of an explosion. When all the gas has been given off, the solution should be shaken thoroughly and allowed to stand for 15 to 30 minutes. The vessel is then opened with as little disturbance as possible; 50 c.c. of the solution should be poured into the heart of each plant. This treatment, also, has to be repeated after three days. Preparation of the calcium carbide solution in an open vessel has led to variable results in Malaya.

De-Crowning and De-Slipping

The crown slip and basal slips of the pineapple begin to develop shortly after the numerous purple flowers have died off.

It is the practice in Malaya to remove the crown. In countries overseas the crown is left on either because the fruit is required for the fresh fruit market or because its removal would result in severe sun-scorch of the fruit. Neither of these considerations applies in Malaya, but there is some evidence that the removal of the crown increases the amount of broken core disease. However, removal of the crown increases fruit size and possibly improves fruit shape.

The crown should be removed, either by hand or with a knife, when it is 2 to 3 in. high. When broken off by hand, the crown should be left in position so that when it withers and falls the scar will have

dried and the risk of the entry of disease organisms is reduced. Cutting the crown off at an angle with a knife leaves no 'cup' for the collection of water and possible entry of disease, but if done carelessly may damage the young fruit.

Removal of slips at the time of de-crowning will also increase fruit size. All the slips of plants with undesirable characters should be removed. The number left on the other plants will depend on the grower's need for planting material. The slips are removed by hand or with a forked stick.

Harvesting

To produce a good quality canned product it is essential that the fruit should be picked fully ripe, transported carefully to the factory and canned as quickly as possible after picking. With the fruit from the less accessible smallholding areas, several days may elapse between harvesting and canning and well ripened fruit may be rotten before it reaches the factory. However, growers should regard the minimum degree of ripeness for harvesting to be when the bottom two to three rows of eyes have turned yellow.

Losses, through fruits which were overlooked during one picking being rotten before the next harvesting, are reduced to a minimum if this degree of ripeness is adopted and harvesters are sent into the area every five to seven days.

The harvester should move slowly and systematically up and down the rows of the area collecting the ripe fruit in a basket which is worn on the back and is large enough for 20 to 30 fruits (Fig. XII). The fruit is piled carefully by the roadside for collection by lorry or is sent to the loading point along a light railway. Where harvesting paths have been cleared, small tractors, such as the Ransomes M.G.6, with trailers or sledges can be used to take out the fruit. Such trailers, carrying 1,000 lb. of fruit, are in use on the Department of Agriculture's stations, but larger trailers might well be tried.

It is essential that at all times the fruit should be handled as gently as possible. The pineapple bruises easily and bruises spoil it for canning and also facilitate the entry of diseases.

The recommended maximum depth for stacking pineapples in a lorry is 14 in. Full loading of the lorry can be achieved by the use of platforms or by using boxes. A suitable box would be one made of meranti timber (*Shorea* spp.) in the form of a crate with the following internal dimensions:—14 in. deep, 12 in. wide and 22 in. long. The ends and bottom should each consist of two boards and the sides of three boards. The gaps in the ends should be ¾ in. wide and those in the sides and bottom of the crate should be ⅝ in. wide.

Over-ripe fruit should not be sent to the factory as it has a fermented flavour and the amount of trimming required is excessive. Immature fruit should not be used because it gives an unsatisfactory canned product.

It is advantageous to have fruit graded before reaching the cannery. At present, grading is done by weight, but grading by size might prove a more satisfactory basis of payment for smallholders' fruit.

The cannery should be sited as close to the growing area as possible and would be ideally situated in the plantation so that the fruit could be processed immediately after harvesting.

Operations after Harvesting

The general practice in Malaya today is continuous cropping as opposed to replanting after the first or second ratoon harvest. This being so, greater care must be taken with the ratoon crops.

After the fruit has been removed from the mother plant, the suckers and slips continue to draw nutrients from the plant. Two to three months after harvest the upper part of the old plant will have died back and should be cut off. The suckers should be checked at the same time and those which are not firmly rooted should be taken off; the suckers which measure 18 to 24 in. can be planted in any empty spaces in the rows. Larger suckers, on being replanted, tend to come into flower immediately and produce very small fruits and no slips or suckers. Poorly rooted suckers which are replanted only after they fall over under the weight of the developing flowers or fruit are apt to produce fruit with broken core disease. It is therefore important that at the time the mother plant is cut back the suckers should be checked and replanted where necessary.

Old plants, together with suckers and slips of plants showing undesirable characters, should be split lengthwise (to prevent regeneration) and be chopped up to form a mulch between the rows.

Use of Fertilisers

Smallholders have grown pineapples on deep peat for many years without using fertilisers. It is now known, however, that by using fertilisers a considerable increase in yield can be obtained and that the fruit size and quality are improved.

Major Elements

In common with other plants, the three nutrients required in the greatest quantity by the pineapple are nitrogen, phosphate and potash. When the soil is unable to supply these to the plant in sufficient quantity, the grower has to make up the balance by the application of organic manure or inorganic fertilisers. For pineapples, only inorganic fertilisers have so far been proved to be of economic benefit.

Nitrogen

Nitrogen is required for vigorous vegetative growth including suckering. It does not, however, play the dominant role in Malayan pineapple fertiliser programmes that it does overseas. Nevertheless,

with the increase in the initial population planted and the use of hormones to advance flowering, the need for applying a nitrogenous fertiliser is increasing.

Nitrogenous fertiliser should not be applied near the time of flowering. If it is applied within two to three months of natural flowering or within one to two months of the application of a flower-inducing substance it will tend to encourage vegetative growth at the expense of the flowering.

Nitrogenous fertilizers can be applied at any time up to the ninth month to plants which are expected to bloom either artificially or naturally when 12 months old; they should not be applied after the eleventh month to plants expected to bloom when 14 months old. The encouragement of vigorous growth of the mother plant will ensure the production of a good sized fruit which can be harvested when the plant is 17 to 19 months old.

If a nitrogenous fertilizer is applied when the fruit is just beginning to develop, a poor quality fruit will be produced; if it is applied about two months before harvest, however, the growth of the suckers for the ratoon crop will be encouraged and the quality of the fruit will not be adversely affected.

Fasciated crowns are thought to be the result of the presence of excessive nitrogen.

Sulphate of ammonia (21 per cent nitrogen) has in the past been generally accepted as the best source of nitrogen. Urea (44 to 46 per cent nitrogen) is also now available. In South Africa, urea was found to be less efficient than an equivalent amount of sulphate of ammonia (8). No comparison of the two substances has yet been made in Malaya, but it is thought that under Malayan conditions the two substances would be of equal value and it is suggested that the choice be made according to availability and comparative price per unit of nitrogen. The higher percentage of nitrogen in urea means that less bulk has to be carried.

Phosphate

Little is known of the phosphate requirements of the pineapples grown in Malaya. It has been found that added phosphate increases the uptake of potash, but several trials have so far failed to show any increases in yield or quality of fruit from the application of phosphate fertiliser.

Phosphate is however essential for the plant at about the time of flowering. The need for balanced fertilising is now becoming clear and is discussed later.

The use of rock phosphate from either Christmas Island (36 to 38 per cent P_2O_5) or North Africa (30 per cent P_2O_5) is recommended. Christmas Island rock phosphate is cheaper per unit of P_2O_5 but may not always be available.

Potash

Potash is the nutrient required in greatest quantity for pineapples

in Malaya. A lack of potash will result in poor plant growth. In the early stages of growth this deficiency is made obvious by the slow growth of the plant and the thinness and lack of body of the leaves, which are also of poor colour. A serious deficiency will almost completely check growth. The leaves turn a mottled red-yellow and show die-back of the leaf-tips. Few suckers or fruit are produced.

The judicious application of potash fertilisers encourages vigorous growth of the mother plant and its suckers and ensures production of fruit of good size. The application of potash has also been shown to improve fruit quality by raising the percentages of total sugars and total acidity.

Experiments have shown that there is no advantage to be gained from the use of sulphate of potash (48 per cent K_2O). The cheaper and less bulky muriate of potash (60 per cent K_2O), is therefore recommended.

BALANCED FERTILISER (MAJOR ELEMENTS)

It is known that the application of phosphate increases the uptake of potash but that excess phosphate reduces the uptake of nitrogen. The uptake of nitrogen is said to be dependent on the presence of potash. Again, it is known that the application of nitrogen or phosphate alone can have a detrimental effect on the growth of pineapple.

It is clear that it is most important not only to apply the three major elements but also to ensure that they are applied in the correct proportions. The Department of Agriculture, by means of field trials and leaf analyses, is seeking to determine what these proportions should be. The interim programme set out in Table I is suggested for the guidance of growers of the Singapore Spanish variety.

Table I

Recommended Fertiliser Programme.

(Singapore Spanish variety at an original population of 7,250 plants per acre).

Nutrient	Fertiliser	Period after Planting			
		2 months	8-9 months	2nd years	3rd and later years
		Application Rate (lb. per acre)			
Nitrogen	Sulphate of ammonia	100	100	145	215
	or				
	Urea	50	50	70	105
Phosphate	C.I.R.P. *	60	60	70	100
	or				
	N.A.R.P. †	75	75	80	120
Potash	Muriate of potash	50	90	170	250

* Christmas Island rock phosphate † North African rock phosphate.

Method of Application

The fertilisers should be weighed out carefully and then mixed thoroughly.

Application of the fertiliser by hand is still recommended. The fertiliser should be placed within 9 to 12 in. of the base of the mature plant. The roots of the pineapple are not extensive and fertiliser placed farther away than this will be lost to the plant. For the first application to the young crop, the fertiliser should be placed nearer than 9 in., as the roots are not yet fully developed. Care must be taken that the fertiliser does not enter the axils of the young leaves or they may be severely scorched by the muriate of potash.

In the second and subsequent years the fertiliser can be applied in two six-monthly applications, the first one being given one to two months before the main harvest.

Application of fertiliser by means of leaf spraying is under trial but no recommendation can yet be made.

TRACE ELEMENTS

Of the trace elements—that is, those substances required by the plant in only very small amounts—it has proved necessary to supply only additional copper, although a lack of zinc has been suspected. The symptoms of deficiency of these two substances are noted in the section "Pests and Diseases" under the names Green Die-Back (copper) and Crook-Neck (zinc).

As a general practice, growers are advised to make regular applications of copper. This can be done either by adding copper sulphate powder to the fertiliser mixture or by a foliar spray application of Bordeaux mixture. Lime must be added to the copper sulphate solution or severe leaf scorching will result. The method of preparing the Bordeaux mixture is given earlier in the section "Preparation of Planting Material". The solution should be checked for neutrality before use. If blue litmus paper turns red when it is dipped in the solution, or if a deposit of copper is left on a clean steel surface dipped into it, insufficient lime has been used. The spray solution should be carefully filtered before being poured into the sprayer. Knapsack sprayers are in almost general use and a number of makes which will give a suitable fine spray are now available at prices from $35 upwards.

Annual or semi-annual spray applications to supply 5 to 10 lb. of copper sulphate per acre will be sufficient.

Mulching

A mulching trial, including the use of mulch paper, is now (1957) in progress on one of the experiment stations of the Department of Agriculture. No recommendation can yet be made, but there is no evidence so far to show that mulching with material other than the cut-up parent plants would be of economic benefit.

Shade

A shading trial is still in progress but there has been no evidence to suggest that growing pineapples require shade.

Pests and Diseases

Mealybugs

With the Singapore Spanish varieties, the early sign of an attack by mealybugs (*Dysmicoccus brevipes* (Ckll.)) is a change of colour (to red) of the apical ends of four to six of the leaves of the second and third whorls from the top of the plant. Later, this coloration moves down the leaves, the ends of which turn yellow and later wither. Later still, other leaves may be affected and bumps or warts be produced on the lower leaves. Another early symptom of attack is a marginal yellow mottling, often variegated with pink.

The Selangor Green variety cannot produce the red pigment and the symptoms of attack by mealybug are marginal mottling and, later, a change of leaf colour to a pale yellow green.

A diagnostic test, which requires some experience, is to remove a thin strip of the discoloured epidermis. In plants attacked by mealybugs the underlying tissue will be white or yellowish white; in all other cases it will be green.

A plant on which the symptoms of attack are very marked may be found free from mealybugs; the pests will have moved to the next plant *along* the row.

Mealybugs are usually found in the lower leaf axils or on the roots, though they may occasionally be seen clustered round the base of a fruit nearing maturity. Pineapples are not the only hosts of this pest.

The Sarawak variety appears to be less susceptible to attack than the Singapore Spanish.

Control measures have not yet been found necessary in Malaya. However, it is suggested that large quantities of material could be fumigated with methyl bromide; effective control could be achieved for small quantities of material by dipping in "Besudin 20E" (1:800) for five seconds and then stacking upright for 24 hours. These measures are expensive to undertake and if they are contemplated it is suggested that growers should seek the advice of the Department of Agriculture beforehand.

Other Pests

Other pests which eat either the fruit or the young leaves of pineapples are monkeys, musang (civet), pigs and rats. Growers who have difficulty in controlling these pests should contact the local Agricultural Officer for advice.

Red Wilt

The leaves of some varieties of pineapples will, under adverse

conditions, turn red due to the production of the pigment anthocyanin. Such varieties are Singapore Spanish and Sarawak, though not Selangor Green. This condition is often referred to as 'red wilt' and it is widely but erroneously believed to be a specific disease.

The most common causes of this coloration are:—

(a) bad drainage. It is essential to ensure that the drainage of an area is satisfactory before the pineapples are planted. Subsequently, drains must be maintained.

(b) soil in the heart of the young plant. This can be prevented by careful planting and weeding.

(c) a lack of consolidation of the soil round the base of the plant. This can be prevented by following the advice given in the section 'Planting' and in the section 'Action After Harvest'.

(d) an attack on the plant by termites. These insects can be killed with a solution of dieldrin.

(e) an attack on the plant by mealybugs. Though mealybugs are found throughout the pineapple-growing areas of Malaya, they are not yet a serious pest. Good drainage and careful cultivation and manuring appear to prevent their attacks having serious consequences.

Fruit Collapse (Ghost Fruit, Fruit Rot)

Fruit collapse is one of the most serious diseases of pineapples in Malaya and has resulted in the loss of 30 per cent of the fruit grown in some areas. It appears to affect the plant crop particularly. The bacterium causing the disease is a specialised strain of *Erwinia carotovora.*

The symptoms are a very rapid rotting and liquifying of the tissues of fruit just approaching maturity. The internal tissues are affected by a very soft rot and assume a dull, water-soaked greenish colour. Gas is produced and there is copious exudation of juice. Affected fruits have a characteristic sour smell. The outer tissues remain relatively firm, but the skin of the fruit assumes a dull yellow-green colour.

No cure is possible and methods of prevention are still under trial. Rigid sanitation should be adopted; where it is possible, affected plants should be buried to prevent the spread of the infection from them.

Heart Rot

Heart rot can also be serious, particularly in newly planted areas. The causal organism is the same as that for fruit collapse, a strain of the bacterium *Erwinia carotovora* (7).

Plants can be affected from the age of three months to the time of flowering and the first symptom is a basal soft rot of the youngest leaves. This later spreads until the growing point and the bases of the first and second whorls of leaves are affected. A distinctive sour smell is noticeable.

FIG. I

Planting materials of the pineapple.

FIG. II

Multiple crown.

FIG. III

Fasciated crown.

FIG. IV

Collar of slips.

FIG. V

Bottle neck.

Fig. VI

Fasciated fruit.

Fig. VII

Slender fruit.

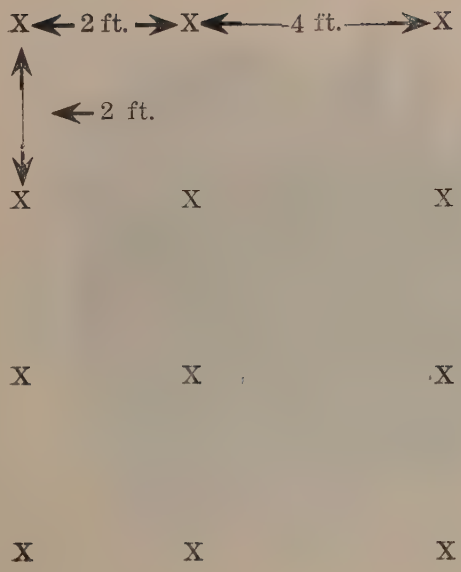
Fig. VIII

Spiny leaves.

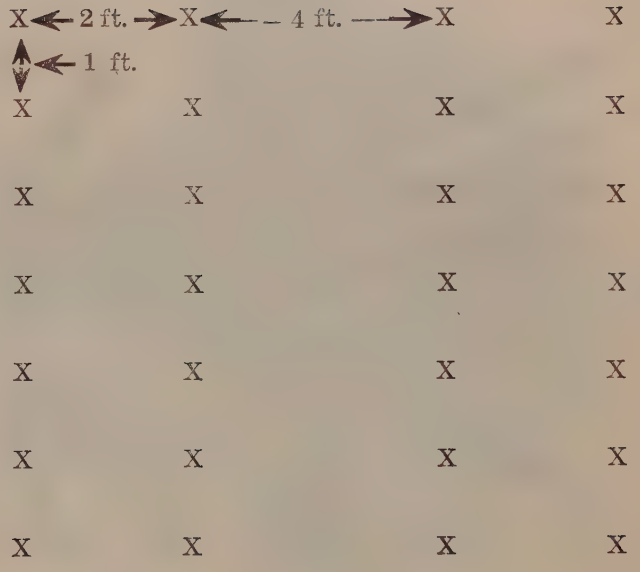
Fig. IX

Prolification.

FIG. X



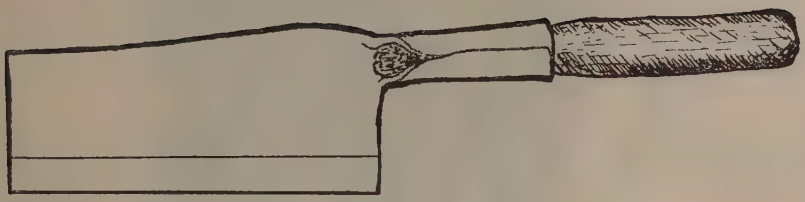
Singapore Spanish (Smallholdings)



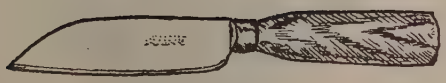
Singapore Spanish (Estate) and Sarawak.

PLANTING DISTANCES

FIG. XI



Short parang.

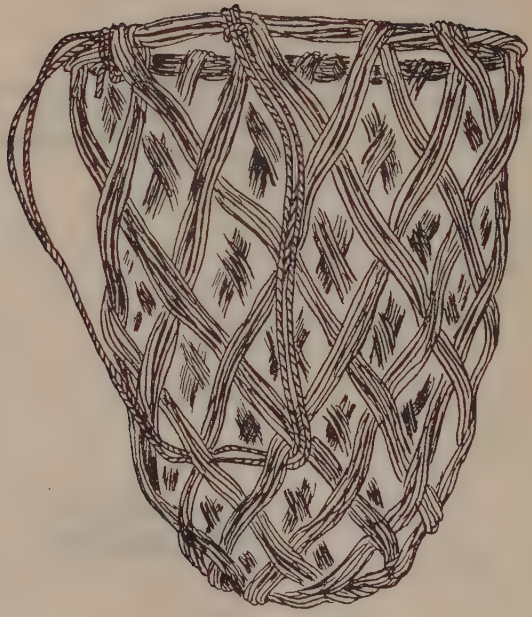


Harvesting knife.

Hormone measure. (50 c.c.)

Hawaiian planting tool.

FIG. XII



Harvesting basket.

FIG. XIII

Broken core.

Trial methods of control are still in progress, but the methods suggested below are aimed at reducing the chances of infection by simple field practices which can be easily and cheaply carried out:—

(i) Slips should be treated before planting by dipping them in Bordeaux mixture to reduce the danger of early infection. (This is also done to guard against green die-back, caused by copper deficiency);

(ii) Care should be taken when planting and subsequently to prevent the entry into the heart of the plant of possibly contaminated soil;

(iii) Badly infected plants which are likely to be completely killed by the disease should be dug up and destroyed by burning or deep burying; and

(iv) Slightly affected plants in which the rot does not extend to the outer leaves often recover by producing lateral shoots. To aid recovery of these plants and to prevent their acting as centres of infection, the central rotted leaves should be pulled out and destroyed and the heart should be sprayed with Bordeaux mixture or some other copper fungicide.

Fruitlet Brown Rot

No symptoms of fruitlet brown rot are noticeable externally. On the removal of the skin, however, a brown rot is evident just below the floral cavities. These brown patches are well defined, as only individual fruitlets are affected, the tissues of which are rotted and turn brown. The rotted tissues are firm and there is no liquefaction; the rot may extend to the core. If two adjacent fruitlets are both badly affected the rot appears in cross section as a wedge of brown, almost black, decay, possibly with a red-brown margin. The rot appears to be caused by a bacterium, (*Erwinia* (?) *ananas*) which is often accompanied by a species of the fungus *Penicillium*.

Application of muriate of potash, which will increase the acidity of the fruit juice, may prove beneficial. Fortnightly spraying of fruit with Bordeaux mixture from flowering onwards has been practised in the Phillipines but has not been tried in Malaya.

Broken Core

Broken core is a transverse break in the core of the fruit (Fig. XIII). It results in the upper part of the fruit not developing properly. Affected fruits ripen from the top downwards and may be of poor shape. The portion of fruit above the break is usually a pale colour and less sweet than the lower part. The disease is not parasitic in origin and may be caused by unfavourable water conditions at some time during the growth of the fruit. Core rot may also be present.

Core Rot

The symptoms of core rot are a fairly well defined brown or greyish rot extending down the core. At first only the core tissues are

affected, but later the flesh also may be involved. The diseased tissue remains firm. Though the core may become hollow, liquefaction of the tissue does not take place and the rot remains localised.

The affected tissues appear similar to those infected with fruitlet brown rot and it is possible that it is caused by the same bacterium.

The causal bacterium probably enters through wounds made by de-crowning.

Ripe Rot

Ripe or over-ripe fruit may be affected by a rather soft rot which causes the disintegration of the flesh and makes it appear water-soaked. There is a superficial resemblance to fruit collapse but ripe rot can be distinguished by the fact that:—

(i) only ripe or over-ripe fruits are affected;
(ii) the affected flesh is yellow rather than the greenish colour of the disease fruit collapse;
(iii) the skin of the fruit is orange rather than greenish-yellow;
(iv) affected tissues are populated largely by yeast rather than bacteria.

Other Diseases

Other diseases of pineapples in Malaya which have been noted but are of minor importance are fungal leaf spots (*Asterinella stuhlmanni* and *Curvularia* sp.) and butt rot (*Ceratostomella paradoxa*).

Trace Element Deficiencies

Green Die-Back

Green die-back is often referred to as green wilt although the affected plant does not wilt. The disease is found in small, scattered places in many pineapple-growing areas. Usually the younger plants are affected, often in groups of only two or three plants.

The leaves of affected plants are brighter green than the leaves of healthy plants, are thin and narrow and are held notably erect. Successive leaves produced by affected plants are shorter and narrower. There is no reddening of the leaves and no wilting of the younger leaf-tips occurs. Affected plants may die if not treated.

The application of copper as suggested in the section "Use of Fertilisers" will control the disease.

Crook-Neck

In Australia and South Africa a deficiency of zinc is often associated with a lack of copper. The disease is referred to as 'crook-neck'. The symptoms shown by a Cayenne plant suffering from a lack of zinc are said to be a marked thickening and twisting of the leaves, which become brittle. The leaf edges curl upwards and there is a yellowing of the leaf. The symptoms are most marked in young leaves. The name

'crook-neck' arises from the inability of the young leaves to fan out; the whorl of young leaves twists round. Later, necrotic patches occur on the leaves. A diagnostic test is said to be one in which the distribution of chlorophyll is examined. If a leaf appears mottled when it is held up to the sun, indicating an uneven distribution of chlorophyll, the plant is suffering from a lack of zinc.

Growers who find plants showing symptoms of crook-neck are advised to contact an officer of the Department of Agriculture.

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DEVELOPMENT OF THE PEAT SOILS OF MALAYA

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Introduction

Preliminary investigations suggested that the total area of peat soils in Malaya is of the order of 1,000,000 acres (6). Later information suggests that this figure may be nearer 2,000,000 acres. Though this is a relatively large area, it appears small when compared with the 40,000,000 acres in Indonesia (25), the 2,600,000 acres in the Florida Everglades (4) and over 5,000,000 acres in Minnesota (19).

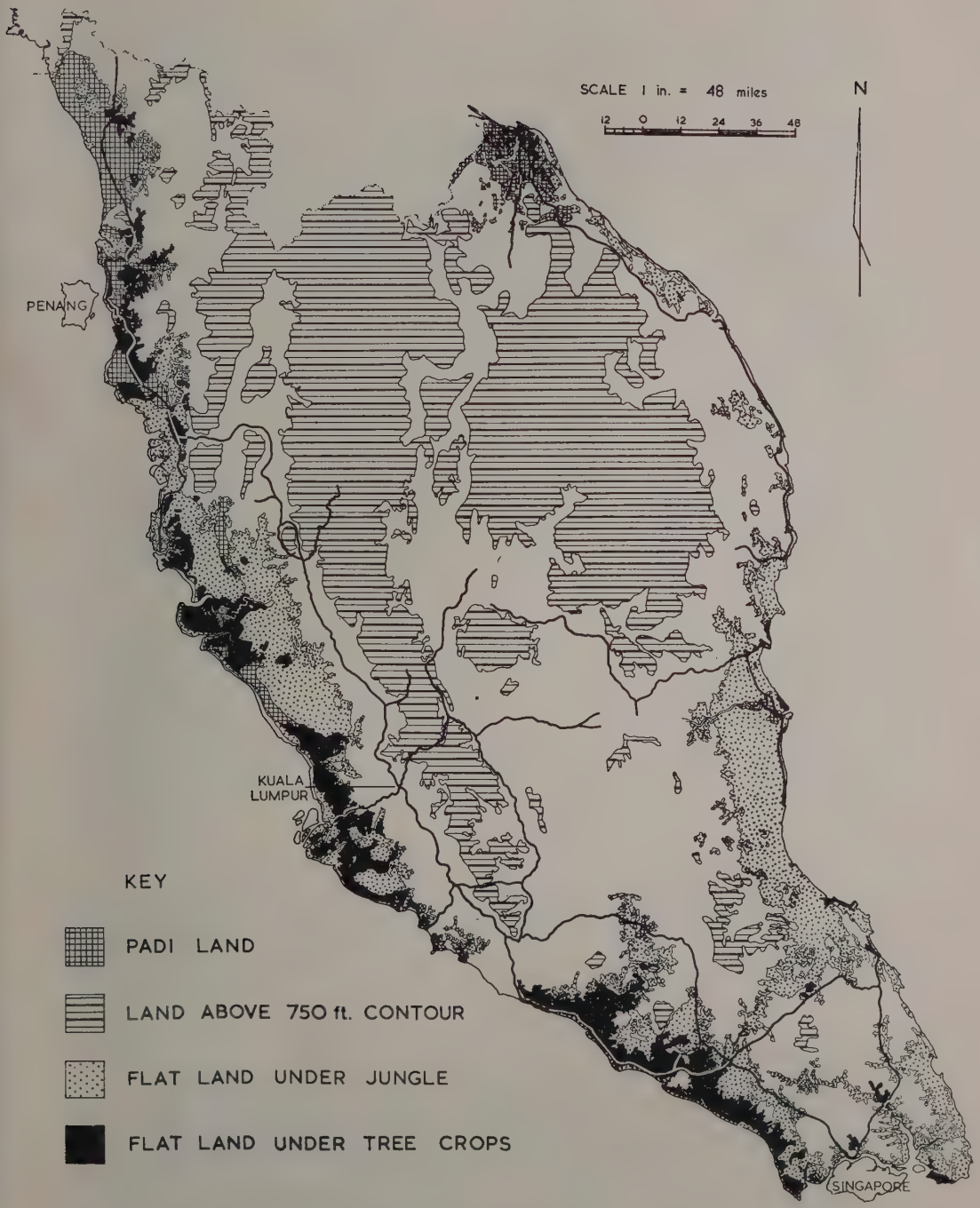
The peats of Malaya constitute a major obstacle to the development of the flat alluvial plains, large areas of which are covered with a layer of peat; the purpose of the present article is to review the problem, in the light of recent work in Malaya and elsewhere, and to suggest further lines of investigation. Perusal of the literature reveals comparatively little work on tropical peats, especially when compared with that in sub-tropical areas, e.g. Florida, or in temperate areas, e.g. Sweden, Germany, Ireland, and northern U.S.A. This is no doubt due to the inaccessibility of peat areas, lack of land pressure, and lack of research staff.

Results Of Recent Surveys

During the past six years, detailed soil surveys have been carried out (7, 8) and these have given further information on Malayan peat soils, particularly as regards area, depth and nutrient content. The surveys have shown that while the peats from several areas differ considerably in ash content and depth, they are all essentially similar in being forest peats.

Apart from the physical and chemical composition, an important difference between Malayan peat and that of Florida or Europe is the nature of the underlying material. In Florida it overlies limestone and the preservation of the peat is therefore essential, since its disappearance would expose the barren rock. Similarly, in Europe the peat frequently overlies boulder clay, a raw material, often very stony, and with little to recommend it as a cropping medium. In Malaya, on the other hand, the peat overlies alluvium which, although containing toxic salts in certain cases, is exceedingly rich in plant foods, since it has never been drained and therefore leached. In the coastal belt the clay level is generally above mean sea level and rises on a flat gradient inland so that natural drainage should be possible.

Large areas of Malayan coastal soils remain to be soil surveyed, but it was possible to delineate the areas of flat land on topographical maps and from these to make the small-scale map shown herein. There is considerable evidence to show that the areas of swamp jungle on the



BASED UPON SURVEY DEPARTMENT MAPS. GOVERNMENT COPYRIGHT RESERVED.

west coast contain much peat, but little is known about the large area between Pekan and Endau on the east coast. Casual reports indicate that this area also contains much peat, although there are ridges of sand nearer the coast.

As well as being potential agricultural land, the peat swamps contain valuable timber, as shown by Forest Department surveys. One such survey is reported for the Hutan Melintang Forest Reserve in South Perak, an area which is mostly deep peat except for a deposit of alluvial mud along the banks of the rivers (14). The predominant species is *Shorea rugosa*, which grows to approximately 150 feet with the first branch about 100 feet from the ground. Examination revealed a stocking of this species of 7.7 trees to the acre with girths of over 4½ feet. Strangely enough, the poorest stocking was on the alluvial soils close to the river. Another notable feature was the good regeneration of the *Shorea rugosa*.

In another report (28), regarding the Kuala Langat Forest Reserve, it is stated that the principal timbers are *Shorea rugosa* (*meranti bakau*) and *Shorea teysmanniana* (*meranti bunga*) with some *Koompassia malaccensis* (*kempas*) and *Gonystylus bancanus* (*melawis*). It is also stated that these forests regenerate very easily and that the future crop should be much richer in valuable species than the original one.

It is thus apparent that the peat swamps have a considerable value for forestry. Nevertheless, the development of most of the flat land in Malaya for agriculture seems inevitable, for much of the steep land, although suited for forestry, is not suitable for agricultural development, particularly for production of food crops. In this connection it is of interest to note that in order to continue to supply just over half of its requirements of rice, as at present, Malaya will require an additional 600,000 acres of padi land 25 years hence, if yields remain at present levels.

Disposal Of Peat

It is generally recognised that the clay soils underneath the peat are more suitable for agriculture than the peat itself and thus the ultimate destruction of the peat is desirable. Though little work has been done on this aspect of the problem, it is worthwile discussing it in more detail.

By Removal

Peat can be disposed of by removal elsewhere, as was done in the Moss of Blairdrummond in Scotland (11) where the peat was removed and floated down the River Forth to the sea. This practice had to be abandoned, however, because of the effect on the salmon and oyster fisheries. In the Netherlands, large areas of peat have been dug out for fuel and the resultant lakes have been drained to expose good agricultural land.

By Burning

However, any disposal of peat on a large scale would have to be as a result of destruction *in situ,* either by burning or by natural oxidation. Burning has always been recognised as a means of increasing the fertility and decreasing the acidity of peat and is a recognised method of cultivation by Chinese market gardeners working on it. Usually the surface layer of the peat, together with the timber, is scraped into rows and burnt, and the resultant ash is spread over the ground.

The small-scale burning of peat by market gardeners does not provide an answer to the problem, however, and large-scale burning is not an easy operation. A search of the literature reveals no evidence of attempts to dispose of peat on a large scale by burning. This is no doubt due to the fact that in most cases where experimental work on peat has been carried out, efforts have been directed towards conserving it. In Malaya, attempts were made some years ago to burn the peat at Tanjong Karang. This involved digging drains at close intervals (of about 1 chain) and, after the peat had been drained, setting it on fire at the edges of the drains. This proved unsuccessful as most of the fires did not spread, though, for some unaccountable reason, sparks from these fires sometimes started a fire in the area between two drains. It has also been noted that in some places peat has been ignited accidentally and has burnt for some time over considerable areas and to considerable depth. It is probable, however, that to burn any large quantity it would be necessary to heap the peat into large windrows and allow it to dry thoroughly before burning. This would have to be done mechanically and thorough drainage of the area beforehand would be essential. In order to dry out the peat it would seem best to drain the area while the jungle remains standing, so that the trees would transpire a large proportion of the moisture.

Where peat is used for fuel on a large scale it contains little timber and can be dug out and macerated by machine before being pressed into blocks for drying. Since Malayan peat contains a considerable amount of timber, any mechanical means of harvesting it would be prohibitively expensive, and its use on a large scale for fuel would be impracticable.

By Natural Oxidation

Turning now to the possibility of destruction of the peat by natural oxidation, it has been noted that this aspect of the problem has been studied very thoroughly in certain parts of the world. Though these studies have been directed towards means of conserving peat, they give much useful information on the rate of oxidation.

It is stated (5) that in the Florida Everglades, the peat has shrunk four to five feet since 1916, and that shrinkage continues at the rate of one inch per annum. In the earlier-drained areas the dry weight of the top soil is about double that of the same volume of soil from a

depth of 3 feet. Consolidation accounts for one-third of the shrinkage, but the remainder is apparently due to complete disappearance of the peat. Clayton *et al* (4), reporting on work in the Florida Everglades, show that on peat which was originally 12 feet deep the levels dropped 1.8 ft. in the first two years after drainage and 0.7 ft. in the succeeding two years. That the height of the water table is the most important factor in determining the rate of oxidation has been shown by several experiments in the Everglades. Neller (22) measured the rate of production of CO_2 in columns of peat located in fields with 12 in., 24 in. and 36 in. water tables. The production of CO_2 in the fields with 24 in. and 36 in. water tables was approximately 9 and 14 times greater, respectively, than in columns in the field with a 12 in. water table. Stephens (29), also working in Florida, has put forward a formula to give a measure of the rate of shrinkage. It is:

$$X = \frac{Y - 2.45}{14.77}$$

in which X = subsidence rate in inches per year and Y = average depth of water table in inches.

It is not known how far these values would apply under Malayan conditions. Possibly the rates of oxidation would be slower because of the higher acidity of Malaya peats, though the acidity could be decreased by liming. Removal of the timber would hasten the shrinkage very considerably. The only measurements on rate of shrinkage have been carried out at Jalan Kebun, Selangor. A post driven into the clay subsoil in 1953 so that the top was made flush with the surface of the peat now extends 10 inches above the surface, i.e. a loss of 10 inches of peat in thre years; this post is in an area under coffee where discing has been frequent. In the pineapple area a similarly buried post shows a peat shrinkage of only four inches in the same period. It should be pointed out that this peat had already been cleared of jungle and drained for some years prior to the station being set up.

Cropping Peat

However desirable it is to destroy the peat and use the underlying clay for agriculture, any method of destruction, either by artificial or natural oxidation, is a very long term project and it is necessary to crop the peat meanwhile. The peats can be used for agriculture either by growing crops which suit them under present conditions or by modifying them by manuring etc. to widen the range of crops which can be grown.

The crop which grows comparatively well on peat is, of course, pineapples, of which there are now about 44,800 acres, but it is estimated that the maximum area which would be used by the canning industry is 100,000 acres, i.e. about one tenth of the estimated acreage of peat. Another crop which is reported to do well on the peat soils of British Guiana is Liberian coffee (27). In Malaya, coffee is not grown on deep

peat but grows well on the muck soils. Oil palms and rubber are grown on peat, but where it is deep, growth is poor. Other crops which have been suggested for Malayan peats are tomatoes for canning and vegetables. Vegetables are grown on a small scale, but there is no prospect of opening up large acreages for them. There have also been small-scale trials of coffee, Guinea grass, rambutan, derris and a number of other crops.

Perusal of the literature gives few indications of useful crops for tropical peats. Russian workers have suggested tea (12), but state that lime must be added in amounts corresponding to the exchangeable acidity. It is stated that in Indonesia (25) pineapples and maize are grown after the peat is burnt. It would solve many of our problems if padi could be grown successfully on deep peat. It is stated by Polak (25) that padi remains sterile when it cannot root in the underlying clay. This is, however, not quite true of Malayan conditions where crops, though poor, can still be obtained. Evidence from Japan, also, supports the contention that peaty soils are generally poor padi soils.

Improving Peat Soils

In many countries a vast amount of work has been undertaken on methods of increasing the fertility of peat soils, but again it must be admitted that little of this work has been done on tropical peats. In Mozambique (23) small pot experiments showed that, using tomatoes as indicator plants, 4 tons per hectare of lime gave good growth while 16 tons per hectare killed the plants. Heavy dressings of farmyard manure also gave good results. It seems paradoxical that organic matter should improve growth on peat, but this has been reported from many sources, and it is possible that this addition of organic matter stimulates bacterial action. Thus, growing cover crops for turning into the peat might be a means of increasing fertility.

In Indonesia, Polak (25) recommends that all peat soils be limed with 15 to 20 tons of powdered limestone per hectare initially. After liming, heavy rolling is necessary and addition of nitrogen is essential. She states that plants grown on limed peat without addition of nitrogen are poor and sparse. Phosphate, potash and 50 to 100 kg. per hectare of copper sulphate are also necessary.

Although there are many differences between the peats of tropical and temperate areas, Polak (26), who has had a great deal of experience of tropical peats, suggests that the fundamental problems are the same in tropical as in other peats. No doubt there are many problems of burning, draining and fertilising which are common. For instance, it has been noted that liming in large amounts depresses the uptake of potash (31). Another problem which is of interest to Malaya is discussed by McCool (20), who found that peat soils varied in their capacity to fix potassium and that peats low in ash had a very small capacity for fixation. This seems to agree with experience in Malaya (8) where the greater proportion of the potash in raw peat appears to be readily

soluble. Similarly, in Japan (15, 16) it is reported that addition of clay soil to peat increased the capacity to fix K and prevented its loss in drainage. The addition of clay or sand to peat has also been reported from the Netherlands (9), but such a procedure is laborious and expensive; six hundred tons of earth would be needed to apply a four-inch layer of soil to one acre.

It is well known that burning of peat improves the growth of crops on it, and in this connection the results of a series of experiments, carried out on the peat station at Jalan Kebun, Selangor, on the effect of liming and various degrees of burning are of interest. Detailed sampling of all plots was carried out and the analyses showed that intensive burning, i.e. twice yearly, raised the pH of the 0-to-6 in. horizon by an average of 1.6 pH units, that of the 6-to-12 in. horizon by 0.7 pH units and that of the 12-to-18 in. horizon by 0.6 pH units. On the other hand, a dressing of ground limestone at the rate of 20 tons per acre over a period of three years raised the pH of the 0-to-6 in. horizon by 2.5 pH units, that of the 6-to-12 in. horizon by 2.0 pH units and that of the 12-to-18 in. horizon by 1.8 pH units. These findings are at variance with those recorded by Subramoney (30) and Willis (31) who report that liming has no effect on the pH at a depth of more than an inch or two from the surface. Another interesting fact recorded in these experiments was that burning had no effect on the level of "available" potash in the soils.

The effect of burning on peat is, as yet, imperfectly understood. Apart from its effect in decreasing acidity it may stimulate bacterial activity. In one experiment carried out in pots, a certain amount of peat was burnt in some pots while in others an equivalent amount was removed and burnt outside and the ash then returned; it was found that the peat treated by the former method gave the better growth of maize.

A further problem common to both tropical and temperate peats is the need for copper. Although the need does not appear to be widespread in Malaya, except for pineapples, addition of copper is reported to be necessary for all crops in Indonesia and it is necessary on many temperate peats. Russian workers (3) have pointed out that the phenomenon of an element which may be beneficial at rates up to 1,280 mg. per kg. of peat and yet is toxic in water solutions at a concentration of 0.1 mg. per litre is worthy of investigation.

One problem which is common to peat lands all over the world is drainage. It is necessary to drain all peats before they can be cropped and in many parts of the world extremely expensive drainage systems are installed. It is stated that some drainage schemes may cost up to £50 ($420) per acre (18). Open drains at fairly frequent intervals are desirable to drain peats but, in contrast to sphagnum peats in which drains can be cut with machinery, the forest peat of Malaya is very expensive to drain. Also, mole drains are possible in sphagnum peats but are out of the question for tropical woody peats.

In connection with drainage, the danger of irreversible drying-

out is often stressed. This phenomenon seems as yet to be imperfectly understood. One suggested possible explanation (24) is that the particles have a resinous coating which prevents them from re-absorbing water. In Malaya, the only example of irreversible drying noted by the author was on an oil palm estate where the soil is a peaty clay about 18 inches deep. The dried-out peat had a typical "buck-shot" appearance similar to that seen in the Netherlands. Though irreversible drying of pure peat does not appear to be a danger, it is worth bearing in mind.

Padi on Peat

In Malaya, a considerable amount of work has been carried out on padi, in both field and pot experiments, on the effects of liming, burning, and fertilising with both major and minor elements; some of this work has been reported elsewhere (2). In one experiment in Selangor, so far carried out for two years, liming at 5 tons of ground limestone per acre gave significant increases in yield. In another area in Perak no significant increases were obtained from any trace elements. In Trengganu, burning and phosphate dressings gave very appreciable increases in yield. In contrast with these field results, none of the above treatments had any effect in pot and tank experiments, but nitrogen, especially at heavy dressings (3 cwt. urea per acre), had a very marked effect and doubled the yield.

An interesting report on this aspect of the problem is that on the growing of padi on the saw-grass peats of Florida (13). After sowing, germination was good but after a week the seedlings were unusually yellow, with a brown discoloration of the radicle. Preliminary trials showed that the poor condition of the plants could be corrected by a spray application of ferric tartrate or ferrous sulphate or by application of ferrous sulphate to the soil (up to 1,000 lbs. per acre $FeSO_4$). Results from greenhouse experiments showed that addition of iron increased iron uptake and crop yield and decreased the ash content of the plants. Analysis of the saw-grass peat shows 1.0 per cent Fe_2O_3 (oven-dry basis), which is slightly higher than that found in Malayan peat (6). It would thus appear that the effects of iron are worth further investigation. This is supported by evidence from one field experiment in Malaya where copper appeared to depress the yield of padi while iron increased it (2). It has also been found in pot experiments that copper depressed the yield. The depressing effect of copper while iron is in short supply has been reported for other crops.

One of the problems of growing padi on peat is that of irrigation, since peat bunds are not water-tight and it is virtually impossible to maintain levels. There is also the question of differential shrinkage of the peat leading to irregular surfaces, and thus uneven depth of water giving non-uniform growth of padi. In fact, there is some evidence to indicate that the best growth is obtained from semi-dry padi. In this connection, a recent experiment carried out in tanks has shown that padi

grown on peat with 9 in. of water gives less than half the yield of that where the surface of the peat is just kept moist.

Other Uses Of Peat

Peat has many agricultural and industrial uses in other parts of the world and, while these would not solve Malaya's problem of the use of peat lands, a brief consideration of them gives some suggestions for secondary uses.

In Russia the ash from peat burnt for fuel is claimed to be a useful fertiliser (10) and is said to contain 22.6 to 70.6 per cent $CaCO_3$ and 2.6 to 5.1 per cent $MgCO_3$. In Malayan peat, it is calculated that the average ash content of the Kuala Langat peat (dry) is 19 per cent. The average depth is 7.8 ft. and the acreage, 39,000 so that the total volume is about 490 million cubic yards of peat. One cubic yard of wet peat contains about 130 lb. of dry peat and thus 24.7 lb. of ash. So it can be estimated that the total ash content of the peat of this area is about 5 million tons.*

The peat will never be used for this purpose on such a scale, but it serves to show that if large scale burning of peat were to be undertaken, the ash would be a useful source of fertiliser.

There is also the possibility of using peat for improving poor upland soils. Numerous experiments are reported where the addition of peat to poor sandy soil has improved fertility.

Composting partially decayed peat is another obvious suggestion. Night soil could probably be used to improve quality. McCool (21) composted peat and then determined the nitrate content 31 weeks later. When peat alone was used the material contained 933 p.p.m. of nitrates. When it was composted with 7.5 lb. of sulphate of ammonia, 15 lb. of super-phosphate, 5 lb. of muriate of potash and 50 lb. of $CaCO_3$ per cubic yard of moist peat, the nitrate N value was 4,124 p.p.m.

Some progress has also been made in the preparation of soil conditioners from peat. One such material is "Flotal" (17). This is a material made by treating peat with ferrous ammonium sulphate. The product contains about 72.0 per cent of ferrous ammonium alum, 3.0 per cent free ammonium sulphate and 18.5 per cent humic substances. It is claimed that this material improves the structure of heavy alkaline clays if applied at the rate of 1,000 to 3,000 kg. per ha. Another material which has been produced is "Humon", prepared by treating peat with ammonia. The material is said to be useful for orchards and market gardens (17).

Any fertilisers manufactured in this way from peat will be expensive, but it is possible there would be a considerable demand by market gardeners etc. for a material to improve soil structure.

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* An analysis of a sample of ash gives the following:—

P_2O_5	....	1.80 per cent
K_2O	....	0.94 „ „
CaO	....	6.77 „ „
MgO	....	1.54 „ „

Other possible industrial applications of peat are the manufacture of hard board, peat coke and peat waxes. The value of the peat for hard board depends on its content of cellulose, which in turn depends on its age; the younger the peat, the more cellulose it contains. Peat has been used in Europe to make peat coke and the possibility of using peat coke as a replacement for wood charcoal is worth bearing in mind.

Peat waxes have been investigated in various parts of the world but as yet there seems to be little commercial exploitation of them. Their properties are described by Ackroyd (1) and it appears they contain some useful chemicals. However, no investigation of the waxes of tropical peats has been undertaken and their properties are unknown.

The Future of the Peat Soils

The question now arises as to what is to be the future policy on the development of the peats. Obviously the first requirement is detailed surveys on the lines of those carried out in Trans-Perak and Kuala Langat (7, 8). These will make it possible to delineate the boundaries of the major peat areas, record the peat depths, examine the underlying mineral soils and record the surface levels. Certain areas are known to have valuable mineral deposits beneath the peat and a survey of the mineral potential is also most desirable.

On the basis of these surveys, it should be possible to determine which areas have little future for agricultural development, i.e. those areas which would be too difficult to drain, especially when the peat shrinks, or which have too sandy subsoils. These areas can be given over to forestry, so that long-term plans for their exploitation can be formulated.

Depending on the results of prospecting, some smaller areas may be set aside for mining. Whether such areas can be used for agriculture or forestry after they are mined depends on the state in which the land is left. Other small areas, especially if near centres of population and power, might be set aside for semi-industrial development, as suggested in previous paragraphs, e.g. compost making, fertiliser and peat coke production, and wax extraction. However, the greater proportion of the areas will eventually be developed for agriculture and the question which must be answered is the form of that development. Our experiments to-date show that, with heavy manuring, padi growing on peat has some prospects, but a major obstacle will always be lack of water control due to inability to make water-tight batas*. We could regard padi growing as a temporary method of utilising the peat while it shrinks, but, unfortunately, flooding the peat for half the year is the best way of preserving it, so that the amount of shrinkage under a system of padi cultivation would be very small.

It would seem that the optimum method of developing these peat soils would be to take the potential padi areas, i.e. those areas which could be given an adequate water supply, and crop them with dryland

* batas = bunds.

crops with the ultimate view of getting rid of the peat and then growing padi. During the period of dryland cropping every effort should be made to hasten the disappearance of the peat. Thus deep drainage, burning the peat, and removing and burning the timber are all highly desirable. Adopting this policy would ensure that the present peat areas would be future padi areas.

In order to encourage the opening up of these areas for dryland crops, more research is needed on the range of crops to be grown and their fertiliser requirements. It is also possible that the demand for padi land will become so acute that it will be necessary to grow padi on peat even though expensive fertilisers will be required. In this case it will be necessary to carry out investigations into water control and water requirements of padi on peat. Such investigations are likely to be long-term and consequently expensive.

Summary

The problem of large areas of Malaya's potential padi lands being covered with deep peat is discussed in the light of work carried out in Malaya and elsewhere. It is shown that the problem is one needing a great amount of detailed research work, especially since the demand for new padi land is likely to become more urgent.

A review of the literature shows that little work has been carried out on tropical peat soils in other parts of the world, but the vast amount of work on temperate peats suggests some lines of investigation which might be profitably followed in tropical peats.

Further detailed surveys of the peat areas as well as investigations into methods of using and disposing of peat and the diversification of cropping on peat are needed. If padi is to be grown on peat, questions of water control and the use of lime, nitrogen, phosphorus and trace elements, especially iron and copper, need solving.

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THE CHEMICAL CONTROL OF WATER HYACINTH IN KELANTAN

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History

Water hyacinth (*Eichhornia crassipes*), known in Malay as *keladi bunting* or *keladi ayer*, was introduced into Singapore from Hong Kong early in the century as an ornamental pond plant for the sake of its beautiful blue flowers. Its potentialities as a pig food were soon realised, however, and it quickly became distributed among pig rearers in Singapore and later in the Federation (1).

The plant thrives in warm, still or slowly moving water—conditions which exist througout the country—and propagation in such conditions is extremely rapid, being by seeds and by off-sets which arise from the base of the parent plant.

A single plant established in suitable conditions will multiply rapidly and, if unchecked, will completely choke a pond or a water-course. Bancroft (2) states that he has seen in the West Indies a pond with such an accumulated growth of water hyacinth on the surface that it was possible to walk across it without sinking more than a couple of inches. Similar observations have been made by the writer in Kelantan and elsewhere in Malaya.

The spread of water hyacinth from "escape" plants had reached such serious proportions in Malaya by 1914 that it was found necessary to introduce legislation under the Pests Enactment to prohibit its growth and to make the destruction of growing plants obligatory where they were found to exist.

Legislation was first introduced in Kedah where, in the short space of five years after the plant's first appearance in that state, it had established itself so widely and strongly that it was considered to constitute a serious threat to drainage and irrigation channels. Similar legislation followed in all other States and Settlements and, in fact, the introduction of such legislation has been necessary in all tropical or sub-tropical countries in which water hyacinth has made its appearance, firstly in the United States (Florida), then in Australia, Indo-China, China, India and Ceylon.

In view of the fact that the plant's reputation elsewhere in the world was known, it is perhaps surprising that more than ten years were allowed to elapse in Malaya between the water hyacinth's introduction and the passing of legislation to control it; by the time this action was taken, the weed had obtained a firm hold and achieved a widespread distribution.

Legislation in Malaya calls for the destruction of water hyacinth by collecting it into heaps, allowing it to dry and then burning it. The

main weakness in the effectiveness of the law, however, lies in the fact that the climate of Malaya rarely, if ever, permits sufficient drying to take place, particularly in the bottoms of the heaps, to obtain an effective burn; the onset of monsoonal rains invariably results in young seedlings and living vegetative parts being washed back from the banks into the water, where they immediately begin to multiply rapidly.

Another serious weakness of existing legislation is that it calls upon only the "owners and occupiers'" of land upon which water hyacinth is growing to take the necessary steps to eradicate it. There is thus no provision for the compulsory destruction of this weed either where it occurs floating in mid-stream or where it becomes attached to unalienated river banks or islands. Such "Tom Tiddler's" grounds provide safe multiplication places from which plants continually break away and cause new infestations.

The Occurrence of Water Hyacinth in Kelantan

The Kelantan River, which is the main watercourse in the State, is too swiftly flowing to harbour the growth of water hyacinth; it is subject, in most years, to a rapid and very considerable rise in level, brought about at the turn of the year by the north-east monsoonal rains which are collected in the vast catchment area of Ulu Kelantan by its tributaries, the Lebir, Nenggiri and Pergau Rivers. In the lower reaches of the river, which wind through the deltaic plain, the flood waters find outlet through a number of flood channels constituting short-cuts between the river, which for the most of its length runs roughly parallel with the coast, and the sea.

For most of the year these flood channels are slowly or scarcely flowing streams, not directly connected with the Kelantan River but fed by small tributaries; they provide ideal conditions for the growth and spread of water hyacinth. However, when they are called upon to fulfil their role of flood alleviation, these channels, choked for the most part from bank to bank with dense accumulations of water hyacinth, are unable to discharge the suddenly rising flood waters and widespread inundation of the adjacent land occurs.

Another danger of no small proportions is that of damage to bridges from the weight of accumulated water hyacinth pressed up against them by the flood waters. Most of the roads in the Kelantan Plain run north and south and the flood channels, running east from the Kelantan River to the sea, are bridged frequently throughout their lengths; a number of minor wooden bridges have been swept away in recent years and the safety of main road bridges has been in doubt on a number of occasions.

Methods of Control Used in the Past

The Kelantan Government has long realised the importance of controlling the growth of water hyacinth in these flood channels, particularly in the main channel known as the Sungei Pasir Tumboh which

carries the longest of the main road bridges and along the banks of which a considerable acreage of padi land is situated. A high proportion of this is *padi menghulu* or early wet padi, which is planted on the flood plains early enough for a crop to be harvested before the onset of the north-east monsoon in a normal year.

Each year, a short time before the monsoonal rains are expected to begin, a campaign has been organised and funds have been made available to encourage riverside dwellers to drag masses of water hyacinth onto the banks and to clear a passage down the centre of the channel. This policy has achieved limited success each year and a certain amount of flood water has escaped directly to the sea; flooding to a greater or lesser extent has nonetheless taken place, due to the restriction of the free flow of the water imposed by the large quantities of uncleared weed, and damage or risk of damage to bridges has occurred in most years as a result of plants breaking away from the edges of the cleared channel and accumulating round the piers of the bridges.

This policy was clearly only a palliative aimed at some measure of flood alleviation and was not expected to achieve total eradication; nor did it aim to prevent re-infestation during the succeeding year, with the result that when the next clearance campaign was instituted, blockage was as severe as in the previous year.

The Adoption of Chemical Control

Early in 1956 a meeting of the State officials concerned was convened, at the instigation of the writer, to consider the water hyacinth problem; it was decided that the necessary funds and staff would be provided for the control of water hyacinth in Kota Bharu District and the Department of Agriculture would be responsible for the programme.

A new approach to the control of the weed was adopted, based on the principle of destruction of the large masses of growth and subsequent control by constant patrolling to eliminate new growth.

It was the writer's firm opinion, based on past experience of the use of herbicides for the control of weeds in padi fields (3), that only by the use of one of the selective "hormone-type" herbicides could water hyacinth be brought and kept under control; consequently, the method of control decided upon was the direct application of a "hormone" spray from small boats.

Because the funds available did not permit the purchase of engine-powered sprayers, the control outfits were equipped with "Super" knapsack sprayers; these were chosen for their robustness, simplicity and relative cheapness.

These sprayers, of four-gallon capacity, were modified for mounting on the floorboards of small, typical river craft called locally *Mat Siam*, which were about twelve to fourteen feet in length and could be propelled by one paddler in the stern. The floorboard fitting was by means of slotted lugs brazed on to the base of the sprayers and held

PLATE I

A spraying team set off in a *Mat Siam* boat.

PLATE II

The spraying equipment, consisting of a floor-mounted, foot-operated sprayer, long hose and lance and a set of "standard" measures.

down by wing-nuts so that the equipment could be easily removed for cleaning, repairs or safe custody at night. These sprayers would ordinarily be hand-operated, but they were converted for foot-operation by the paddler while normally seated, so leaving both hands free; only a downward movement of the foot was required, as the return movement was completed by a spring attached to the boat through a suitable linkage. Finally, to allow plenty of free movement and range of spray coverage, an extra-long delivery hose was fitted to the outlet side of the sprayer and to this was attached a long lance made from light bamboo and carrying an internal copper pipe with suitable unions (See Plates I and II).

The choice of herbicide presented no problem, for soon after the decision to adopt spraying had been reached a supply of army-surplus "Trioxone" became available at no cost.

"Trioxone" is a formulation of 2,4-D and 2,4,5-T containing six pounds of acid equivalent per gallon and, although perhaps unnecessarily potent for the destruction of water hyacinth, it proved to be ideal for the purpose. In order to ensure accuracy of dilution and to ease the task of the unskilled labour employed, standard containers were prepared so that one standard measure of concentrated "Trioxone" dissolved in one standard measure of water completely filled a sprayer at a concentration of 1 part "Trioxone" to 80 parts of water. A built-in but detachable fine gauze filter was fitted to the larger container so that ordinary river water could be used for dilution without risk of blocking the spray nozzles. A second filter was placed in the filling orifice of the sprayer.

All equipment had been assembled and modified and the labour had been recruited by the end of March, 1956; spraying started in early April, using two teams of sprayers. Each unit consisted of one *Mat Siam* boat equipped with a "Super" sprayer, modified as described previously, a set of standard measures, and a supply of "Trioxone" concentrate and each was manned by two men, one to paddle and pump and one to spray and refill.

It was originally intended that the two teams should work independently, keeping a parallel course up the river from the Pasir Tumboh bridge and spraying on both sides of their boats to clear a course, initially, up the middle of the river.

In practice, however, it soon became apparent that a single boat on its own could make no progress through the massed water hyacinth, even though the beam of the boat was no more than thirty inches, and it was necessary to detail one boat to go ahead to cut out a path while the second boat followed closely behind before the channel closed in and sprayed on each side a swathe as wide as was possible with the long lance.

The effectiveness of the spray was apparent immediately and sprayed plants could be detected within a few hours. This helped considerably in avoiding double spraying, particularly later when passage

up the river became somewhat easier, and there was never any doubt as to where to start the next day's work.

In hot, dry weather plants became brown and scorched within about one week after spraying; but, no matter how thoroughly the visible parts were sprayed, in places where the growth was really thick some parts of the weeds remained unaffected and were revealed about two to three weeks later growing in the midst of the mass of rotting vegetation.

The second spraying was timed to follow from three to four weeks after the first and this treatment completed the destruction of the water hyacinth.

It was soon found that dealing with solid masses of the weed, as described above, was comparatively simple, but as clearance progressed it became necessary to treat less accessible areas of the weeds, tucked away in small creeks and hidden between the trunks of sago palms, etc., growing along the banks. Also, when the main bulk of the weed in the middle of the stream had been reduced to a rotting pulp, it became apparent that there was a slow surface flow of water which tended to carry downstream small detached clumps of weed, either unsprayed or only once-sprayed. This made it difficult to adhere to a strict spraying programme, since areas previously assumed to be clear would be found to be re-infested. However, at the expense of some unavoidable extra patrolling, it was possible to claim that the length of the Sungei Pasir Tumboh from the main road bridge to its source, a distance of about four miles, was for all practical purposes cleared of water hyacinth by the end of June.

Operations were continued downstream from the Pasir Tumboh bridge to the sea, a distance of about eight miles. Later, one team was dispatched to spray the Sungei Pengkalan Chepa and this was completed before the onset of the monsoon halted operations at the end of the year. The effectiveness of the spraying operations may be gauged by the pairs of photographs reproduced as Plates III A and B and IV A and B.

It should be stressed that complete destruction and control of water hyacinth is not possible and that after clearance has been achieved it is necessary to maintain constant patrols to prevent re-infestation by "escape" plants. In this respect, the operation is similar to the eradication and control of *lalang* (*Imperata cylindrica*), areas of which, after mass spraying, must be regularly patrolled so that re-infestation can be kept in check by spot spraying or wiping of any sporadic growth.

It is difficult to assess the extent of the areas sprayed, except in the case of mass infestations, but it is estimated that areas of about eight acres and seventeen acres, respectively, were sprayed during the first two months, that is before spot spraying became more general than mass spraying.

The amount of spray applied varied with the intensity of the weed-growth, but it was intended that one gallon of concentrate (eighty

PLATE III

A. Spraying in progress. Note the bank-to-bank growth of water hyacinth.

B. The same area two months later. The surface vegetation is *Nymphaea* sp., a type of water-lily.

PLATE IV

A. One day after the first spraying. Note that the leaves are beginning to wilt.

B. The same area less than two months later.

gallons of spray) should be applied per acre. Eight and eleven gallons of concentrate were used during the first two months, respectively. Later, there was a tendency on the part of the recorder to relate the area sprayed to the number of gallons used, and this is perhaps understandable in view of the impossibility of making an accurate assessment of the areas of innumerable small patches receiving spot spraying.

According to available records covering the period April to December, 1956, a total of approximately 128 acres was sprayed, but since in most cases twice-sprayed areas were counted each time they were sprayed, it would be more realistic to state that an area of some 65 to 70 acres of water hyacinth was destroyed.

Costs

Under Capital Expenditure, listed below, it should be noted that the cost of four sprayers has been included, although only two boat units were employed. Three sprayers were bought for use in the boats, to allow one sprayer to be always in reserve and to permit regular rotation of sprayers for routine servicing, replacement of washers, etc.; the fourth sprayer was acquired later in the year for a third two-man team which carried out spraying from the banks of the watercourses.

Capital equipment has been allotted a useful life of three years, which may be an underestimate, but even if five years were allowed this would make but little difference to the annual cost-per-acre figure.

Although "Trioxone" was obtained free, it has been listed under Recurrent Expenditure at $40 per gallon, which was its approximate retail price when it was available on the open market. It is no longer marketed and has been replaced by "Floroxone", which has a similar fomula. "Fernoxone" was used for a short period when "Trioxone" was temporarily not available.

CAPITAL EXPENDITURE:		
(a)	Two *Mat Siam* boats	$ 210
(b)	Four "Super" sprayers and accessories	687
(c)	Mixing buckets, filters, measures, spares, etc.	171
	Total	$ 1,068
	Annual depreciation over three years	$356 per annum
RECURRENT EXPENDITURE (APRIL TO DECEMBER, 1956):		
(a)	Labour	$ 2,740
(b)	"Trioxone" (94½ gal.)	3,780
(c)	"Fernoxone" powder (80 lb.)	134
	Total	$ 6,654
TOTAL EXPENDITURE (APRIL TO DECEMBER, 1956):		
(a)	Share of Capital Cost	$ 267
(b)	Recurrent Costs	6,654
	Total	$ 6,921

Estimated Total Area sprayed in Acres, including Second and Third Sprayings, approximately	$128
Estimate in Acres of Area Destroyed	$65 to $ 70
Calculated Cost per Acre Sprayed, approximately	$ 54
Calculated Cost per Acre Destroyed	$99 to $106

It should be stressed that the calculated costs per acre sprayed and per acre destroyed can only be regarded as rough approximations due to the fact that the acreage figure is not exact. Nevertheless, the figures quoted may be of some use as a guide to others who may be considering this method of water hyacinth control.

It is considered that no useful purpose would be served by hazarding a guess as to the comparative costs of clearance by hand since, for the reasons stated earlier, complete destruction by hand is not possible and the best that can be achieved is temporary clearance of a channel.

Some General Observations

(1) Apart from reducing the danger of floods and of damage to bridges, the clearance of water hyacinth in rivers in Kota Bharu District has brought the following advantages:—

(a) an increase in the acreage of *padi menghulu* planted on the flood plains;
(b) a resumption of river fishing;
(c) free navigation; and
(d) a resumption of sago harvesting, now that the trunks can be rafted down to factories.

(2) Although "Trioxone" is toxic to fish in quite low concentrations, not one single case of fish deaths has been noted or reported. The explanation is almost certainly that most of the spray is deposited on the vegetation and only very little reaches the water. All spraying was carried out over running water, albeit very slowly flowing, and the spray which did fall on to the water must have been diluted to a sub-lethal concentration.

(3) Among the preliminary tests carried out was one in which a gallon of "Trioxone" concentrate was poured into a small gap made in a solid mass of water hyacinth growth which covered a wide expanse of very slowly flowing water. There was not the slightest visible effect on the water hyacinth and it became evident that only by direct application of the spray to the vegetation could control be achieved. The effect on fish in this case was unknown, but if any fish were killed they remained hidden by the unaffected water hyacinth.

(4) Another preliminary trial tested the effectiveness of "Trioxone" applied as a fog, from a pulse-jet "Swingfog". The water hyacinth was killed within about five yards from the machine, but beyond that distance injury decreased rapidly, and it became evident that a greater deposition of active ingredient than was obtainable from a fog-

drift was required to exercise control. The use of this apparatus was also ruled out on the following grounds:—

(a) skilled operators would be required;
(b) the risk of damage to riverside crops from drifting spray;
(c) the danger of accidents to an operator working in the confined space of a small boat; and
(d) the risk of total loss of the apparatus should the boat capsize while the jet-tube was hot.

(5) Other observations made during the course of spraying operations were in connection with the tolerance of water hyacinth to sea-water. While it is evident that water hyacinth does not establish itself or multiply in salt or brackish water, it appears that this weed does have remarkably high resistance to salt water. This is evident from the appearance of detached clumps of the plant which are sometimes encountered floating upstream on the rising tide near the mouth of a river. These clumps show no signs that they have been affected by their encounters with the sea, though it is not known for how long they can withstand a twice-daily salt water treatment. It is obvious, however, that those clumps which are washed out from the mouth of a river and are not returned on the next in-coming tide are physically pounded to pieces by the action of waves on the shore; a small but useful contribution to the weed's destruction is made in this way. Such is the tenacity to life of water hyacinth, however, that rows of young seedlings may be found germinating in pure seashore sand at the high-water mark where their pulverised parents have been deposited. But these seedlings are short-lived and succumb to intense heat and lack of suitable moisture before they can constitute a menace.

Conclusion

The eradication of water hyacinth by chemical spraying is a practical and economic proposition, whereas attempts at eradication by hand cannot be expected to succeed.

Summary

(1) The introduction and spread of water hyacinth in Malaya is traced briefly.

(2) Legislation for the control of this weed is reviewed.

(3) The problem of its occurrence in Kelantan and past efforts to control it are discussed.

(4) The introduction of chemical control measures is described and a note on the cost of chemical control is included.

(5) Various observations made during the course of operations are recorded.

Acknowledgement

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FODDER GRASS CULTIVATION

A Manurial and Variety Trial at the Federal Experiment Station, Serdang

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Introduction

The results of fodder grass trials carried out at Ayer Itam Agricultural Station, Penang, and at Bukit Mertajam Agricultural Station, Province Wellesley, in the early post-war years and reported in 1949 (1) showed that, under the conditions of these trials, Napier grass (*Pennisetum purpureum*) gave higher yields than Guinea grass (*Panicum maximum*), particularly in the first two years after planting, and that substantial increases over the pre-war yields of 16 to 20 tons per acre per year could be achieved by the application of inorganic fertilisers in addition to cattle manure. Henderson (2) described a trial at Serdang (FESS. 78) in which yields of Guinea grass increased with successively larger dressings of sulphate of ammonia (in conjunction with other fertilisers) up to 10 cwt. per acre per year.

In 1949, the Department of Agriculture introduced into Malaya high-yielding Napier grass hybrids which had been developed in Hawaii. These were:—

Napier grass hybrid 47.21,
Napier grass hybrid 47.3,
Napier grass hybrid 34.18,
Cat-tail millet x Napier grass hybrid 47.14,
Cat-tail millet x Napier grass hybrid 47.1.

Of these varieties, hybrid 47.21 failed to establish itself in Malaya but the others grew well and were multiplied at the Federal Experiment Station, Serdang. The trial which is described in this article was carried out with the four Hawaiian varieties which were successfully introduced here and the local strain of Napier grass.

The Trial (FESS. 107)

The objects of the experiment were to compare the yields of five varieties of Napier grass and to assess the effects of applications of 10, 15 and 20 cwt. of sulphate of ammonia per acre per year on yields and protein contents of fresh grass. The experiment comprised six randomised blocks of five plots each (varieties), each plot being split into three sub-plots (levels of manuring).

The varieties tested were:—

(a) Local Napier grass,
(b) Napier grass hybrid 34.18,
(c) Cat-tail millet x Napier grass hybrid 47.1,
(d) Cat-tail millet x Napier grass hybrid 47.14,
(e) Napier grass hybrid 47.3.

The manurial sub-treatments were:—

(A) 10 cwt. of sulphate of ammonia per acre per year,
(B) 15 cwt. of sulphate of ammonia per acre per year,
(C) 20 cwt. of sulphate of ammonia per acre per year.

The size of each main plot was 90 x 16.5 ft. and each sub-plot measured 30 x 16.5 ft. After allowing discards of 2.5 ft. on each side, the harvested area of each sub-plot was 25 x 11.5 ft.

The field was in tea until 1948, when this was eradicated and the land allowed to revert to secondary jungle growth. The area is level and free draining; the soil is Serdang sandy loam. Clearing was carried out in March, 1950, using a tractor and bulldozer. This was followed immediately by ploughing with a tractor-drawn triple disc plough. Stem cuttings of the grasses were planted at the end of May, 1950, at a spacing of 2.5 x 1.5 ft.

Establishment

Early establishment of the grasses was poor, due partly to lack of pre-planting manuring and partly to the shortage of planting material of the Hawaiian varieties. This shortage prevented immediate supplying of vacancies and as a result a complete stand was not obtained until March, 1951. It was observed at this time that the local variety had been by far the easiest to establish.

The field records during the establishment period are incomplete but the available information suggests that, in an attempt to make growth in the trial more even, 3 cwt. of fertiliser mixture was applied at the beginning of 1951. The fertiliser consisted of a mixture of sulphate of ammonia, single superphosphate, and muriate of potash in the ration of 3 : 1 : 3.

Experimental Procedure

The basal experimental manuring commenced in June, 1951, and comprised:—

(i) Single superphosphate at 1.5 cwt. per acre per annum in two equal dressings applied in June and December.
(ii) Muriate of potash at 3 cwt. per acre per annum in four equal dressings applied in June, September, December and March (1.5 cwt. was applied in error in June, 1952).

In addition, one ton of ground limestone per acre was applied in April, 1952.

The experimental manuring with sulphate of ammonia at 10, 15, and 20 cwt. per acre per year was applied in four equal doses each,

in June, September, December and March. The fertiliser was broadcast over the treatment plots including the discard.

The first grass cutting of the experiment was commenced on 8th August, 1951, and thereafter cuts were taken at intervals of 1½ months. After each cut the experiment received inter-row cultivation using a ridger.

The experiment was continued for 20 cuts (approximately 2½ years), of which only the first 16 cuts (2 years) are considered in this article.

YIELDS OF FRESH GRASS

The actual yields of grass obtained are shown in Tables I and II.

Table I

Total Yields of Fresh Cut Grass over the Two-Year Period.
(lb.)

Manurial Treatment	Variety (a)	(b)	(c)	(d)	(e)	Total	S. E. Total
10 cwt. sulphate of ammonia per acre per year (A)	7,333	4,474	5,083	5,038	6,078	28,006	±437.7234
15 „ „ (B)	7,680	4,972	5,954	5,722	6,378	30,706	
20 „ „ (C)	8,218	5,070	6,741	± 195.7599 6,401	6,950	33,380	
Total	23,231	14,516	17,778	17,161	19,406	92,092	
S. E. Total				± 290.3332			

Table II

Yields of Fresh Cut Grass over a Two-Year Period.
(tons per acre per year)

Manurial Treatment	Variety (a)	(b)	(c)	(d)	(e)	Mean	S. E. Mean
(A)	41.33	25.22	28.65	28.40	34.26	31.57	
(B)	43.29	28.03	33.56	± 1.1034 32.25	35.95	34.62	±0.4935
(C)	46.32	28.58	38.00	36.08	39.17	37.63	
Mean	43.65	27.27	33.40	32.24	36.46	34.61	
S. E. Mean			± 0.5455				

Analysis shows that Variety (a) (local Napier) gave by far the highest yields and was followed by Varieties (e), (c), (d) and (b), in that order.

It is also shown that yields were significantly increased ($P=0.01$) by increasing the applications of sulphate of ammonia from 10 cwt. to 15 cwt. per acre per year and from 15 cwt. to 20 cwt. per acre per year, and that there was no difference in the response of the varieties to increasing applications.

Yields of each variety at each level of N application are shown graphically in Fig. I.

Since the two year period recorded here covered in fact the second and third years of growth (due to the poor establishment of the imported varieties), the high yield of the local variety may be due in part to its more uniform maturity. However, records of the yields in the six months immediately following the conclusion of this trial indicate that the yields of all varieties were by then declining and thus the yields of the imported varieties would not have equalled that of the local variety on attaining full maturity.

Analysis of Protein Content

Protein contents were determined chemically and were studied to discover how they had been influenced by increasing the applications of sulphate of ammonia. Samples for analysis were taken at each cut from all sub-plots of Blocks V and VI during the second year of the trial (19th August, 1952, to 25th June, 1953).

The mean protein contents are shown in Table III.

Table III

Mean Protein Content of Fresh Grass in the Second Year

(per cent protein)

Manurial Treatment	Variety					Mean	S. E. Mean
	(a)	(b)	(c)	(d)	(e)		
(A)	2.410	2.515	2.315	2.540	2.400	2.436	
(B)	2.510	2.640	2.615	2.825	2.685	2.655	±0.0238
(C)	2.760	2.870	± 0.0532 2.785	2.920	2.890	2.845	
Mean	2.560	2.675	2.572	2.762	2.658	2.645	
S. E. Mean	± 0.0527						

The figures in Table III show that there were no significant differences in protein content between the varieties, nor were there any

differences in the responses of the varieties to the fertilisers. A marked increase in average protein content caused by increasing the applications of sulphate of ammonia is, however, evident in all varieties.

PROTEIN YIELD

By using the figures for the average protein contents and those for the fresh grass yields obtained from Blocks V and VI over the period 19th August, 1952, to 25th June, 1953, figures for the actual protein yield were calculated. These are summarised in Table IV and V.

Table IV

Total Yields of Crude Protein from Two Blocks in the Second Year (lb.)

Manurial Treatment	Varieties					Total	S. E. Total
	(a)	(b)	(c)	(d)	(e)		
(A)	29.60	25.36	22.42	27.33	24.26	128.97	
(B)	35.34	30.29	29.28	31.61	30.27	156.79	±2.8928
(C)	40.73	35.25	± 1.2937 39.97	38.54	37.75	192.24	
Total	105.67	90.90	91.67	97.48	92.28	478.00	
S. E. Total	± 6.0199						

Table V

Yield of Crude Protein in the Second Year (tons per acre)

Manurial Treatment	Varieties					Mean	S. E. Mean
	(a)	(b)	(c)	(d)	(e)		
(A)	1.001	0.858	0.758	0.924	0.820	0.872	
(B)	1.195	1.024	0.990	1.069	1.024	1.061	±0.0195
(C)	1.377	1.192	1.352	± 0.0437 1.303	1.277	1.300	
Mean	1.191	1.025	1.033	1.099	1.040	1.078	
S. E. Mean	± 0.0678						

The analyses show that increasing the nitrogen manuring has improved protein yield, as was to be expected. Because the number of replications was small, significant differences due to variations were not obtained.

The increase in protein yield due to manuring is shown graphically in Fig. II.

Discussion

Local Napier grass produced a calculated mean yield of 43 tons per acre per year; the highest of the imported strains produced only 36 tons per acre per year. Local Napier also had a leafier appearance and was easier to establish. It is therefore more suited to the conditions at Serdang than any of the imported strains.

All varieties yielded more heavily in the second year of the trial than in the first year, but these differences have not been studied as the early difficulties experienced in obtaining a complete stand of the imported varieties would make any differences between years difficult to interpret. Observations after the trial had terminated indicated that the yields generally were falling; this was to be expected, as the crop was then entering its fourth year of cultivation.

The yield of local Napier grass is the highest so far published for any fodder grass at Serdang. This is partly explained by the fact that sulphate of ammonia applications were higher than ever before, though the yield obtained after an application of 10 cwt. per acre was markedly higher than the yield obtained from Guinea grass also receiving 10 cwt. of sulphate of ammonia in Trial FESS. 78 as reported by Henderson (2). Possibly the type of inter-cultivation, in which a ridger was used, also contributed to the vigour of growth of the Napier grass; however, this method had not given any advantage when used previously for Guinea grass inter-cultivation.

Figures for the increase in protein content indicate that there was a linear response to manuring with sulphate of ammonia; this agrees with results obtained for Guinea grass receiving a lower range of sulphate of ammonia applications (4). The protein contents of the two grasses when 10 cwt. of sulphate of ammonia are applied are very similar: 2.5 per cent for Guinea grass and 2.4 per cent for Napier grass. It appears that the quality of the two grasses is very similar but that higher yields can be obtained from Napier grass than from Guinea grass. The Napier grass fodder, however, contains a moderate amount of thick stem, which is not palatable to cattle, while the Guinea grass fodder is virtually all palatable leaves and fine stems. It is reasonable to assume that if some farmyard manure had been applied and if the rate of application of muriate of potash had been increased to approach Henderson's recommendations—8 : 6 parts by weight of sulphate of ammonia and muriate of potash (3)—yields of 50 to 60 tons of Napier grass could have been achieved. Yields such as this would render Napier grass very valuable for use in a farming system where high yields per acre from a short-term fodder ley were desirable.

Summary

An experiment is described in which five strains of Napier grass and Napier grass hybrids were grown on plots receiving high applica-

Fig. I

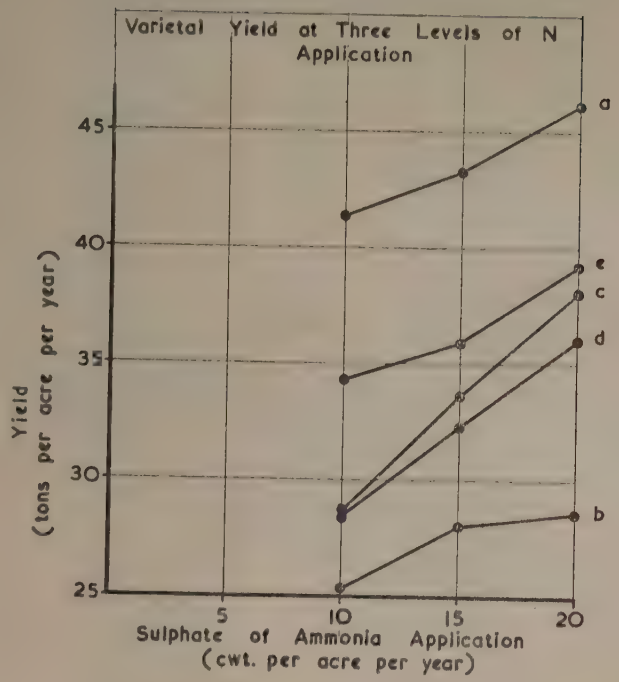
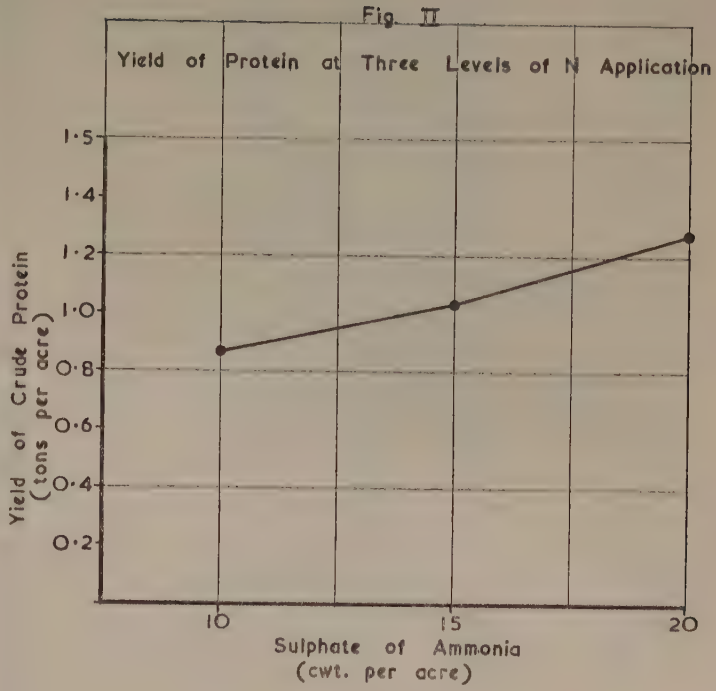

Varietal Yield at Three Levels of N Application
Yield (tons per acre per year)
45
40
35
30
25
a
e
c
d
b
5
10
15
20
Sulphate of Ammonia Application (cwt. per acre per year)

Fig. II


Yield of Protein at Three Levels of N Application
Yield of Crude Protein (tons per acre)
1·5
1·4
1·2
1·0
0·8
0·6
0·4
0·2
10
15
20
Sulphate of Ammonia (cwt. per acre)

tions of sulphate of ammonia, *viz.* 10, 15 and 20 cwt. per acre per year. Yields of over 40 tons per acre were achieved and it is shown that the local strain gave the highest yield and that both the yield and the protein content were significantly increased ($P = 0.01$) by each successive increase of 5 cwt. of fertiliser up to 20 cwt. per acre.

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NINTH INTERNATIONAL BOTANICAL CONGRESS

The Ninth International Botanical Congress will be held in Montreal, Canada, from August 19 to 29, 1959, at McGill University and the University of Montreal. The program will include papers and symposia related to all branches of pure and applied botany. A first circular giving information on program, accommodation, excursions, and other detail will be available early in 1958. This circular and subsequent circulars including application forms will be sent only to those who write to the Secretary-General asking to be placed on the Congress mailing list:

Dr. C. Frankton
Secretary-General
IX International Botanical Congress
Science Service Building
Ottawa, Ontario
Canada

MASTER FARMERS OF MALAYA

BY

LIM TEONG THEAM,

Agricultural Assistant, Bukit Mertajam.

Kum Yeng

This is the story of Kum Yeng, a 73-year-old farmer in the Central District of Province Wellesley.

Kum Yeng is a Cantonese, who emigrated from China at the early age of 12 to settle down in Malaya. For the past 42 years he has been intimately connected with padi planting and the practical experience gained in this line of farming has made him a successful farmer.

Kum Yeng has worked on a two-acre lot of land, which is next to the Padi Experimental Station at Bukit Merah, for the past 15 years, i.e. he has been on this land ever since the Japanese occupation.

In the Central District of Province Wellesley, about 6,000 acres out of the total area of 10,000 acres under padi is double-cropped. Kum Yeng's land is in this double-cropped area. In the off-season Kum Yeng plants a short-term Taiwan Variety called Pebifun while in the main season he plants the Malayan short-term variety Radin Kling. The average yield in this district is around 350 gantangs (gallons) per acre but Kum Yeng is consistently getting not less than 600 gantangs per acre per season with both types of padi. Kum Yeng's annual harvest is therefore around 2,400 gantangs. Setting aside a third of the year's crop to feed his family, he has 1,600 gantangs of padi for sale which brings him an annual income of about $960. Apart from this, he gets from $500 to $1,000 from the sale of 1,000 to 2,000 ducks which he rears annually.

Kum Yeng never sits back when a season's planting has been completed. About a month before harvesting begins, Kum Yeng rears about 500 to 1,000 ducklings. During this time, he rides on his bicycle to Butterworth, which is 5 miles away, to transport *ikan busok* * for his ducklings. The amount of *ikan busok* required to feed his ducklings is around a pikul (133 1/3 lb.) a day. At times when the fish is cheap he makes two trips. When harvesting begins, by which time the ducklings are a month old, they are left in the padi field to forage for themselves. They are only called back at night when they are given their meal for the day.

While the ducklings are in the field and up to the time when they are sold at the age of 70 to 80 days, they play an important part in Kum Yeng's land by feeding on worms and insects and increasing soil fertility through their droppings; last, but not least, they trample on the decaying padi straw and thus incorporate it into the soil, saving him the expense of ploughing his land. Apart from this, Kum Yeng applies

* *ikan busok* = local fish meal.

to his land a liberal amount of droppings collected from the duck pens. He reckons that the amount of droppings applied to his land per season amounts to 20 pikuls; this makes him independent of artificial fertilisers.

What is the secret of Kum Yeng's success? This can be answered in four words—hard work and understanding. Even at such an elderly age, Kum Yeng is equal to—if not better than—many a young padi planter. In planting his padi, he makes it a point to follow the padi planting dates so that he can have time, which is indeed limited, to prepare for the next season's crop. The diligence of Kum Yeng is mentioned, but he is also understanding. Understanding in what sense? He understands his land. He understands that what is taken from it has to be repaid and this Kum Yeng never fails to do. He repays his land with a liberal application of manure. He understands also that only so long as his land is kept well nourished will it be able to keep on giving him a good crop.

Kum Yeng is just an example of a hard-working and successful farmer. There may be many who are as diligent and as successful as he. But if the *whole country* had farmers of Kum Yeng's calibre, self sufficiency in rice for our country would be assured.

PLATE I

Kum Yeng at work on his padi farm.

PLATE II

Kum Yeng distributes bundles of padi seedlings in preparation for transplanting.

NOTES ON CURRENT INVESTIGATIONS AND EXTENSION WORK

April to June, 1957.

Weather

Severe drought conditions were experienced on the Selangor Coast, especially in the north, and total rainfall for the first half of the year was less than 20 in. in parts of the Kuala Selangor district. Elsewhere, rainfall has been seasonal or somewhat below average.

Padi

RESEARCH

Extension of the programme for the production of higher-yielding padi varieties under the Draft Development Plan is now actively under way. Among the results of last season's work at padi stations which have so far been analysed the following are of interest.

The Kedah selection Subang Intan 117 has outyielded the standard Kelantan variety, Anak Naga, at Kota Bharu, Pasir Puteh and Pasir Mas in Kelantan by 5, 10 and 33 per cent, respectively. New selections of Mayang Sa-Batil (M.S.B.) have, however, given only small yield increases of the order of 5 per cent over M.S.B. 8 at Genting (Penang), Sungai Acheh (Krian) and Briah (Krian). At Pulai in South Kedah, Subang Intan 16 outyielded all other varieties tested, giving an average yield over three seasons of 4,346 lb. of padi per acre, a 10 per cent increase. Where there is a demand for short-grained rices, planters are being encouraged to grow these varieties.

In trials which have not yet been completed, seraup 50 continues to give excellent results in North Krian with yields greater than those of Seraup Kechil 48 by 35, 24 and 24 per cent at Kuala Kurau, Simpang Tiga and Titi Serong, respectively. At Kendong (Negri Sembilan), Serendah Kuning 30 significantly outyielded the hitherto-best variety, Serendah Kuning 11, by 22 per cent in the first year of trial.

Selection work on 10 other major varieties is proceeding.

In trials in 35 plots on planters' land in the coastal area of Malacca, the new selection Nachin 39 outyielded the varieties usually grown by 15 to 20 per cent, which represents a yield increase of 106 gtg. (gantangs) per acre in Alor Gajah District (Coastal), 52 gtg. in Central District and 69 gtg. in Jasin District (Coastal) or 68 gtg. per acre, overall.

Crosses between the non-photosensitive *indica*, Radin Kling, and other photosensitive *indicas* have shown no signs of flowering within 120 days of planting in March, and it appears that non-sensitivity is recessive in crosses between local *indica* parents. This is in contrast to dominant non-photosensitivity in photosensitive *indica* x non-photosensitive *japonica* crosses, from which the F_1 was 100 per cent non-photosensitive.

Symptoms of *penyakit merah* have been induced in pot cultures in the presence of excessive soil potassium and were aggravated by magnesium and possibly phosphorus deficiency. It is necessary to check the findings in the field.

Among the minor elements, preliminary tests show that rice may have a high zinc requirement, is tolerant of excessive copper and molybdenum, but is susceptible to excess manganese and boron.

Investigations carried out last season on the attack of padi by stem-borer showed that infestation was very low in all padi areas and that damage done by borers may be expected to vary considerably from season to season. Even in a season of low borer-incidence an appreciable loss of crop occurs, but insecticidal control measures which will reduce this loss are not economic unless borer incidence is high and losses serious. These investigations are being continued.

AGRONOMIC INVESTIGATIONS AND EXTENSION

A detailed review was made of the results of fertiliser extension trials carried out in Kedah and Perlis from 1954 to 1956. This showed that economic responses to the fertilisers tested were commonly obtained, but that there were very large variations in the extent of these responses, even within areas of the same soil type. It is likely that these variations are largely caused by differences in husbandry practices etc. between holdings. This has a dual significance; it requires that such practices must be described for each experimental site, in the course of investigation, and it suggests that, ultimately, fertiliser recommendations should be related to sets of farming conditions rather than to finite areas of land.

In the off-season 6,650 acres have been planted in Province Wellesley, 462 acres in Yen district of Kedah and—a new development—200 acres in south Krian. This last venture will be watched with great interest as growth to date has been satisfactory.

Preparations are in hand for the extension of padi manuring in all territories. Considerable emphasis is being placed on correct nursery technique, especially on the use of Ammophos 11 : 48, together with the importance of such factors as seed separation, nursery size, seed rate and age of seedlings at the time of transplanting. Sixty demonstrations of correct management are being laid down in Kedah, while in Kelantan some 10,000 leaflets on nursery manuring have been distributed.

In the riverine mukims (mukim = parish) of Pahang, nursery manuring is the only form of manuring that is practicable and this is being popularized by demonstrations.

Field manuring is not being neglected and two-plot demonstrations are being planned on a country-wide basis. This practice will be subsidized next season in Kelantan, Trengganu, Malacca and Negri Sembilan. In Malacca the subsidy scheme has been amended because of many outstanding debts and farmers now have to pay the portion of the cost not covered by the subsidy in cash at the time of sale.

In Kelantan 20,000 leaflets have been issued on field manuring, of which half were printed by Government and half at the fertiliser manufacturer's expense.

Seed farms in Malacca and Negri Sembilan have yielded well and in the former territory 1,231 pikuls of seed-padi have been purchased at the bonus price of $18 per pikul. So far 351 pikuls of this have been issued on exchange to farmers. Similarly, in Negri Sembilan about 280 pikuls of pure strain seed padi, mostly Serendah Kuning 11, are available for distribution.

The Padi Planters Board continues to do good work in Kedah where Padi Planters Associations now have a registered membership of 35,632 in 219 branches. The Board's activities are summarised as follows:—

Activity	*No. of Farmers Benefited*	*Area Affected*
Redemption of mortgages	54	208
Redemption of usufructuary loans	90	359
Purchase of land and re-sale to members	20	95

The sum expended on these three activities has amounted to $301,397.

Rubber

During the quarter the following quantities of improved planting material have been distributed to small growers:—

	Budwood (Yd.)	*Clonal Rubber Stumps*
For re-planting	28,349	831,286
For new planting	20,794	545,353
Total	49,143	1,376,639

The proposed scheme for aid to new planters has stimulated an interest in suitable land and many areas have been inspected by officers of the Department of Agriculture. In Trengganu 5,183 acres have been approved for new planting and 1,508 acres have been given out in Kedah for the same purpose.

In Negri Sembilan 333 gallons of the arboricide 2,4,5-T have been supplied to replanters for poisoning their old trees. In the same territory the insecticide aldrin, formulated as Aldrex-2, has been popular for termite control.

In Pahang the Department has co-operated with the Rubber Industry Replanting Board in spraying twelve acres of replanted rubber with the new herbicide Dowpon against lalang (*Imperata cylindrica*). The progress of this demonstration will be watched with great interest since this chemical is non-poisonous.

A good example of co-operative effort has been reported from the two isolated kampongs (villages) of Menerong and Ulu Brang which can be reached after 2½ days travel upstreams from Kuala Brang,

Trengganu. Rubber growers now sell co-operatively and they have benefited by an extra 5 cents per kati in selling price.

Cacao

The first phase of the breeding programme has been completed and by the end of this year representative progenies from all selected mother-trees will have been planted in trials.

Twig-die-back and leaf chlorosis of cacao which have been becoming more serious in Selangor and Trengganu cacao plantings in the last few months have been found to be closely associated with deficiencies in the plant of calcium, manganese and possibly iron.

Investigations to determine optimum conditions for cacao fermentation are continuing and have shown that under-fermentation may be preferable to over-fermentation in that over-fermented beans are more liable to mouldiness, the effects of which cannot be eradicated, whereas under-fermented cacao containing around 10 per cent purple beans tends to be acid with an acetic odour; both of these defects can be removed in processing so that good chocolate is produced. Other current work on cacao is aimed at finding the best conditions and methods of drying fermented beans.

Yields of pods were higher in the first half of 1957—the main bearing period of the year at Serdang—than in the same time in 1956, but were still well below the 1955 figures. The quarter's crop from seed gardens at the Federal Experiment Station, Jerangau, was smaller than that in the corresponding period of 1956.

In the 18-acre area of the Jerangau Pilot Scheme growth has been good with no further damage reported by *kijang* (barking deer) or other pests. Lining has been in progress on the balance of 30 acres. Nurseries for this area have been well maintained and growth of the seedlings has been excellent.

Growth of cacao under mature coconuts on Lower Perak estates has been exceptionally good.

There are now the following areas of commercial cacao in Malaya:—

Unit		*Territory*		*Area (acres)*
Estate A	....	Trengganu	....	449
„ B	....	„	....	356
„ C	....	Lower Perak	....	79
„ D	....	„	....	50
„ E	....	„	....	50
Jerangau Pilot Scheme	....	Trengganu	....	18
Total	....		....	1,002

With the exception of 26 acres of Upper Amazon on estate A, all this consists of West African Amelonado cacao. In addition there are considerable areas under experiments and seed gardens.

Oil Palm

In connection with the co-operative breeding scheme to produce higher yielding oil palm varieties, 27,580 seed of 31 hybrid families have been distributed to most estates for experimental purposes.

Coconuts

Various fertilisers have been applied to young, new planted palms on an estate in the Bagan Datok area and the results of these tests are most interesting. Considerable improvements in growth and nut development are clearly evident where the palms have received a fertilisr mixture containing nitrogen and phosphate.

Responses to fertilisers, in numbers of nuts per palm, have begun to increase considerably over the past nine months in the manurial experiment on smallholders' land in Trengganu.

Four applications for loans for the purpose of drainage improvement on coconut holdings in Lower Perak have been approved by the Planters' Loan Board.

In the Sri Menanti Drainage Area, Johore, recent improvements to drainage have enabled farmers to undercrop with bananas and these have given heavy yields.

When the new bund is completed from Tampok to Benut about 1,000 acres of new land will become available for coconut planting and this has all been applied for. Land in this part of West Johore is now changing hands at $1,000 per acre, a price which reflects the benefit from drainage improvements.

In Johore South large flocks of poultry and also pig herds are kept on coconut land at Kampong Jawa, Sungei Rengit and Pengerang. The livestock thrives and the palms benefit from the intensive farming.

In Trengganu four manurial demonstrations have been laid down on coastal sands in Marang and Besut Districts using locally available supplies of clay, peat, ashes and animal and fish refuse.

Pineapples

In Johore the peak of the fruit crop, in June, unfortunately coincided with difficulties in the canneries and large quantities of smallholders' fruit were either left unharvested or else rotted on the roadsides. It is claimed that at present prices production is uneconomic and widespread loss of confidence in the crop is anticipated amongst growers. Because of reduced attention to manuring, fruit size is said to be decreasing in most areas, although the Jeram Batu area is exceptional in this respect.

In Selangor very good crops were harvested during May and June and the Klang cannery purchased 7,666,700 lb. of fruit from smallholders through middlemen. Growers obtain 5 to 8 cents per fruit and are not at present interested in selling direct to the cannery.

Fruit

Nineteen demonstrations of correct orchard management have been laid down in Trengganu with emphasis placed on regular manuring and pruning.

A total of 10,748 clonal fruit trees and 284 seedlings have been sold during the quarter.

Coffee

There is a keen demand for Liberian planting material from cultivators in the Kuala Sungei Bahru area of Malacca and some 5,700 seedlings have been sold to them from Sungei Udang Agricultural Station.

A further 180 acres of Liberian coffee have been planted in Johore Central during the quarter.

Vegetables

Caterpillars of the diamond-back moth, *Plutella maculipennis*, have become resistant to DDT and BHC. Effective control has however been obtained by weekly spraying with a 0.04 per cent solution of diazinon as Basudin 20E to within two weeks of harvest. Yield was thus increased by 15 tons per acre. Unlike dieldrin, diazinon left no toxic residue on the cabbage at harvest.

A total of 3,000 acres of food crops are grown on padi land in Malacca and Selangor during the off-season.

Wax gourds have proved to be a good catch-crop for young coffee areas in Selangor, as yields of up to 200 pikuls per acre have been reported.

Tobacco

In Trengganu 293 acres have been planted, largely as an off-season crop on padi land. In the previous season the total area was 400 acres, the drop in area being due primarily to very dry weather after the padi harvest. The average yield in this area is about 4 pikuls (533 lb.) per acre, of which 50 to 65 per cent is sold as Grade I prepared tobacco at $500 to $600 per pikul.

In Lower and Upper Perak leaf size from the early crops has been small because of dry weather in June. Prices for cured leaf in Upper Perak have been as follows:—

Grade I	....	....	$145 to $180 per pikul
Grade II	....	....	$80 to $140 „ „
Grade III	....	....	$60 to $ 80 „ „

Kelantan tobacco farmers are becoming more fertiliser-conscious as a result of Departmental propaganda and 5 tons of a mixed fertiliser have been sold in the Tanah Merah district alone.

Pastures, Fodders and Livestock

Initial observations of growth and habit of several East African Guinea grass strains indicate that K 51270(F), K 51270 & K 52530 are superior in leafiness to Tanganyika, K 51345(Gori) and K 11363 (Rangwe). Very good yields of fresh grass were harvested from observation plots of *Panicum trichocladum*.

Young Sindhi x local crossbred cattle were received at Gerai Padi Station and are being trained for ploughing etc; they are to be compared in this with local animals.

Fifty-nine boars and 68 gilts have been sold to pig-rearers during the quarter. In addition, stud Middle White boars have performed a total of 426 services in new villages and stud farms.

Ninety cockerels and 198 pullets have been sold by the Department during the quarter, together with 1,642 eggs for hatching and 17,905 for consumption. In addition, commercial hatcheries in Perlis, Kedah Perak and Malacca have sold 339,400 ducklings and 269,500 chicks at prices of from 22 to 30 cents each. These are very largely bought by padi farmers after harvest in order to utilise fallen grain.

Soil Survey

Progress in the detailed mapping of the soils in the padi areas of Kedah has been slower than was anticipated owing to the short period of two months in which the soil is sufficiently dry for field work. Additional staff will be used on the survey next season. Meanwhile, a similar survey has been commenced in Kelantan where the dry season is longer and this is proceeding rapidly as the soils there have proved easier to identify than those of the Kedah plain.

A rapid inspection of the relatively unexplored areas south of Pekan and around the Sungei Rompin and Sungai Pontian in Pahang reveals extensive tracts of poor peat swamp overlying infertile sandy soil. The upland soils in the area are also poor. Some good padi land, subject to monsoon flooding, was found in the upper reaches of the rivers, but there is little prospect of extensive padi development or, on the upland soils, of intensive agricultural development in this area.

Survey of the upland soils of Ulu Kelantan is proceeding much more rapidly this season with the increased staff. Much of the land inspected was found to be too steep for agricultural development but appreciable areas of good granite soils are being located to the east of Kampong Jeli and along the Jeli-to-Batang-Merbau road.

Fruit Processing

Reports on samples of papaya cannned in syrup sent to England for commercial appraisal are unpromising. The fruit tends to disintegrate in transit and papaya flavour does not appeal to the overseas consumer in competition with canned fruits such as peaches, pineapple and apricots, etc.

An investigation to compare the qualities after canning of pineapple taken from the first crop to the fifth ratoon crop showed no significant quality differences. With successive ratoons, however, the size of the fruit progressively lessened and eye-depth was found to be positively correlated with fruit size (the smaller the fruit, the shallower the eyes) but not with the age of the planting.

Discoloration of concentrated juice has been found to be related to the temperature of pasteurization. Alternative methods of preservation by cold storage or the use of preservatives such as sulphur dioxide are under trial.

Education

Two ten-day courses in home preservation of local fruits and foods for members of Womens' Institutes have been completed; a third is in progress and three more courses are planned. Trainees are being taught to preserve foodstuffs in glass jars and cans and to prepare jams, jellies, etc. These include papaya, pineapple, pomelo, mangosteen, rambutan, kundang, mango and guava preserved in syrup, preservation of various types of beans, carrot, bamboo shoots, and lady's fingers, preparation of mangosteen, pineapple-papaya and papaya-ginger jams and guava jelly, and canning chicken in curry.

Courses for 194 students were held at Rural Agricultural Training Centres and elsewhere in all territories except Malacca and Trengganu.

REVIEWS

An Introduction to the Botany of Tropical Crops.

By L. S. Cobley, *Pp.* xv + 357 + 82 plates + 66 fig. (London, New York and Toronto: Longmans, Green & Co. 1956.) 37*s*. 6*d*. ($16.50)

This book, written to meet the needs of the agriculture student, is an excellent attempt at filling a long-felt want. Limitations of space have forced the author to be selective; nevertheless, some 400 species are listed in the index and over 100 are dealt with in greater or less detail in the text. The principal tropical cereals, fibres, oils, legumes, starches, spices, beverages, drugs, fruits, vegetables, rubbers and essential oils are dealt with in twelve chapters. The main omissions are the gums and resins, dyes and tans, and fodder and forage crops. A subject and a species index is provided and the book is liberally furnished with photographs and line drawings which are not, unfortunately, referred to in the text.

The arrangement of the crops according to their products, though lacking botanical justification, makes the volume a useful companion to the standard texts on tropical agriculture. The botanical treatment is largely confined to morphological features and brings together conveniently for the first time a wide array of hitherto scattered facts. More histological information would have been useful and a wider botanical field could have been covered by the omission of much geographical and utilisation data which is readily available in other texts.

The style is easily readable but in places ambiguous; one may be led, for instance, to the erroneous conclusions that the cacao tree is deciduous, that the female inflorescences of the oil palm are formed below the male and that upland rice occurs mainly at high altitudes. There are errors—the oil palm bunch bears nearer 2,000 than 200 fruits —, but inspite of these defects, which are no more than are usually found in a first edition covering a new biological field, this publication is an interesting and most useful reference and should be available to everyone interested in tropical crops.

L.N.H.L.

The Storage of Seeds for Maintenance of Viability.

By E. Biasutti Owen. Bull. No. 43 of The Commonwealth Bureau of Pastures and Field Crops. *Pp.* 81. (England: Commonwealth Agricultural Bureaux, 1956.) 20*s*.

The storage of seed in viable condition is an acute problem in the tropics, as high temperature and humidity are the two most important conditions of rapid seed deterioration. This publication deals with the subject from the viewpoint of the plant breeder who often needs to maintain small stocks of valuable breeding material for considerable periods. The approach is therefore scientific and the treatment is in the form of a review of published work on most aspects of the subject.

Over 150 species are to be found in the index and this include 30 or more agricultural plants which are commonly grown in the humid tropics. The storage characteristics of over 100 species are conveniently

summarised in a twelve page appendix. Some 550 references to published literature are listed.

Among the subjects covered in the ten chapters are the effects on viability of the initial and subsequent moisture content of the seed; the composition and humidity of the storage atmosphere; temperature effects, particularly in relation to seed drying; storage methods and equipment, including containers; metabolic and genetic changes in stored seed; the relation of storage conditions, including seed treatment, to pests and fungal and other parasites; and the causes of dormancy and its effect on longevity of stored seed.

The problems of efficient seed storage, peculiar as they tend to be to each separate species, are by no means solved. But the array of data presented provides many useful guides to better storage and should prove of practical value to all who are concerned with the storage of viable seed, and not only to plant breeders.

L.N.H.L.

The Underground Organs of Herbage Grasses.

By A. Troughton, Bull. No. 44 of the Commonwealth Bureau of Pastures and Field Crops. *Pp.* 163. (England: Commonwealth Agricultural Bureaux, 1956.) 25s.

The book is a review of published research relating to the roots, rhizomes, corms, etc., of grasses grown for their foliage. It is written in four parts containing some 70, 50, 9 and 4 pages respectively. The first is descriptive of the organs and their parts and deals with their chemical composition and life history. The second part concerns the effect of the environment on these organs and the third the effect of the organs on their environment, the soil. The fourth part briefly surveys the techniques which have been developed for root study. Over 700 references are listed in a bibliography.

So little work on tropical grasses has been done that the treatment is necessarily almost entirely confined to temperate species and conditions; of the nearly 200 species listed in the index only some 15 are commonly grown in the tropics. The work is primarily of scientific interest and should prove a valuable reference to the agrostologist. Though it contains little of direct agricultural application it will provide the scientifically minded farmer or practical agriculturist with a better understanding of the functions of the herbage plants with which he is concerned.

L.N.H.L.

Obituary

It is with the deepest regret that we record the death of Enche Mohammed Arif bin Abdul Rahman, Assistant Lecturer, College of Agriculture, Malaya. Enche Mohammed Arif passed away peacefully on the 23rd July, 1957, at the Bungsar Hospital, Kuala Lumpur, after a sudden relapse of his long illness. With his passing, so soon after the untimely death of Mr. John Chattaway, the College has suffered another loss of a very experienced member of the staff who will not be easy to replace.

Before joining the Department of Agriculture in November, 1954, Enche Mohammed Arif was a Rubber Instructor in the Smallholders' Advisory Service of the Rubber Research Institute of Malaya. During his period of service in the Department of Agriculture, he held many appointments in the Field and Education Branches. While on the staff of the College, Enche Mohammed Arif was awarded a Colombo Plan Fellowship which took him to New Zealand, where he made a special study of the poultry husbandry of that country.

He was an honest, sincere and ready worker. As a lecturer he was always painstaking and helpful and he possessed an unique manner of imparting his knowledge to the students in a simple and easy way. He always inspired a high degree of interest in the subjects he taught. His good sense of humour made him readily accepted in any company and he was very popular with both students and staff.

To his widow and children we extend our deepest sympathy and most sincere condolences.

Awards

Tuan Haji Mahmood bin Haji Ya'acob, Assistant Agricultural Officer, Kelantan, was awarded the Seri Mahkota Kelantan by H.H. the Sultan of Kedah on the occasion of His Highness's birthday on August 9th, 1957.

Enche Hussein bin Isa, Junior Agricultural Assistant, was awarded the Pingat Bakt by H.H. the Sultan of Kedah on the occasion of His Highness's birthday on August 9th, 1957.

Promotions

The following promotions have been approved:

Name and Rank	*Promoted as*	*Date*
Enche Mohd. Muda bin Mahmood	Assistant Agricultural Officer	6-5-57
Mr. H.J. Simpson	Deputy Director of Agriculture	8-5-57

Mr. R. Henderson	Senior Agricultural Officer, Grade A	8-5-57
Mr. A.L. Barcroft	Senior Agricultural Officer, Grade B	8-5-57
Mr. A. Johnston	Senior Research Officer, Grade A	2-7-57
Mr. F.N.G. Conaty	Senior Research Officer, Grade B	2-7-57

Appointments

The following appointments have been made:

Name and Rank	*Appointed or Posted as*	*Date*
Enche Salim bin Mohd. Akib, Assistant Agricultural Officer, Kedah	Deputy Chairman of the Board of Administrators, Government Rubber Replanting Schemes, Ministry of Commerce and Industry	17-5-75
Wan Mohamad Don bin Mohamad	Pupil Agricultural Officer	20-8-57
Mr. A.V. Haddon	Acting Senior Botanist	26-8-57
Enche Ahmad bin Mohd. Amin	Settlement Agricultural Officer, Penang	20-7-57
Mr. Ng Ngok Wah	Assistant Agricultural Officer, North Pahang	1-7-57

Retirements

The following officers have retired under the Tenth Schedule to the Federation of Malaya Agreement (Amendment No. 4) Ordinance, 1956:—

Name and Rank	*Date*
Mr. H.K. Ashby, Senior Agricultural Officer	2-7-57
Mr. A. E. Billington, Senior Chemist	2-7-57
Mr. P.A. Gething, Senior Agricultural Officer	2-7-57
Mr. I.J. Wyatt, Entomologist	2-7-57
Dr. W.N. Scott, Senior Agricultural Officer	5-9-57

Leave

The following officers have proceeded on leave prior to retirement:

Name and Rank	*Date*
Mr. J.J. Holmes, Publications Officer	2-6-57
Mr. J.R. Milburn, Agricultural Officer	19-7-57
Mr. M.G. Hawson, Agricultural Officer	8-9-57

The following officers have proceeded on leave:

Name and Rank	*Date*
Mr. N. Kanagaratnam, Agricultural Development Officer	9-7-57
Mr. J.A. Cox, Agricultural Development Officer	10-8-57

Dr. J. Dore, Plant Physiologist 22-8-57
Mr. F.B. Brown, Senior Botanist 27-8-57
Mr. T.R. Dickinson, Agricultural Officer 31-8-57

The following officers have returned from leave:

Name and Rank	*Date*
Mr. C. Whitehead, Agronomist	3-7-57
Mr. A. Johnston, Senior Plant Pathologist	8-8-57
Mr. A.V. Haddon, Botanist (Plant Breeder)	6-8-57
Mr. A. Cumming, Agricultural Development Officer	9-8-57
Mr. G.W. Arnott, Soil Chemist	16-9-57

April to June, 1957.

Rubber.—The noon prices paid for R.S.S. No. 1 (f.o.b. in bales, buyers) in Singapore were fairly stable during the second quarter of the year. Average daily prices for April, May and June were 91.75, 90.23 and 92.30. The highest price during the quarter was 94.75 cents per pound on the 12th of June and the lowest was 88.75 on the 7th of May. These compare quite favourable with average monthly prices for April, May and June, 1956, which were 90.56, 83.41 and 83.29 cents per pound, respectively.

The average prices paid for small-holders' rubber at three towns in the Federation of Malaya are given in Table I. Table II shows production figures.

Tea.—About 1,500,000 lb. of tea were produced in the Federation of Malaya in the April-June period, an increase of 300,000 lb. over the previous quarter. The average prices paid in London for teas from Malaya and other countries are shown in Table III.

Coffee.—Table IV shows Liberican coffee prices at two towns in Selangor.

Other Agricultural Products.—The production figures for palm oil appear in Table V and those for copra and copra products, in Table VI. Tables VII and VIII show the Singapore prices and pan-Malayan export figures for various agricultural products.

Table I

AVERAGE MONTHLY PRICES PAID BY LOCAL DEALERS FOR SMALL-HOLDERS' RUBBER, APRIL TO JUNE, 1957

(dollars per pikul *)

Grades	Taiping, Perak			Seremban, Negri Sembilan			Batu Pahat, Johore		
	April	May	June	April	May	June	April	May	June
Smoked Sheet No. 1	104.53	101.82	104.06	104.13	102.24	104.22	—	—	—
Unsmoked Sheet	89.69	87.03	—	82.80	83.43	—	88.66	88.32	—
Scrap	45.84	46.50	48.11	54.30	56.14	57.61	33.74	35.19	37.40

* 1 pikul = 133⅓ lb.

This table has been compiled from statistics supplied by the Chief Statistician, Federation of Malaya.

Table II

RUBBER PRODUCTION
FEDERATION OF MALAYA

(long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1956	1957	1956	1957	1956	1957
January -	32,515	36,076	26,428	27,184	58,943	63,260
February -	27,503	27,002	23,848	21,998	51,351	49,000
March -	28,408	25,908	22,433	20,915	50,841	46,823
April -	26,591	26,501	21,647	22,460	48,238	48,961
May -	23,389	27,129	19,703	18,305	43,092	45,434
June -	29,409	29,628	23,109	21,583	52,518	51,211
July -	30,709	32,405	23,807	24,054	54,516	56,459
August -	30,201	32,957	22,927	23,119	53,128	56,076
September -	30,123		21,774		51,897	
October -	30,386		22,455		52,841	
November -	28,363		21,179		49,542	
December -	34,636		24,058		58,694	
Total -	352,233		273,368		625,601	
Total 1955 -	351,802		285,281		637,083	

This Table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

Production on smallholdings (estates of less than 100 acres) is taken as the total of purchases from smallholders reported by licensed dealers.

Table III

AVERAGE PRICES PAID IN LONDON FOR TEA

(s.d. per lb.)

For the Week Ending	Malayan	Ceylon	Indonesian	India		Africa
				Northern	Southern	
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
4.4.57	Nil	4 2.04	3 6.07	3 6.45	3 6.78	3 0.49
11.4.57	3 2.40	4 2.64	3 2.06	3 6.61	3 7.06	3 0.79
18.4.57	Nil	4 2.55	3 0.97	3 6.61	3 6.46	3 1.02
2.5.57	3 6.43	4 4.85	3 5.55	3 8.74	3 6.93	3 1.69
9.5.57	3 4.80	4 5.90	3 3.67	3 8.65	3 8.85	3 2.18
16.5.57	4 10.42	4 7.78	3 2.92	3 8.83	3 8.20	3 1.17
23.5.57	3 6.69	4 7.01	3 1.34	3 7.83	3 6.90	3 0.34
30.5.57	3 1.24	4 6.07	3 0.47	3 7.65	3 6.85	2 10.75
6.6.57	3 2.19	4 2.81	3 1.07	3 7.83	3 5.88	2 10.30
20.6.57	3 3.01	4 0.96	3 0.43	3 8.77	3 5.17	2 11.03
27.6.57	3 7.04	4 0.87	3 1.04	3 9.46	3 5.14	2 11.93

Table IV

AVERAGE DEALERS' PRICES FOR DRIED LIBERICAN COFFEE BEANS GROWN IN SELANGOR*

(dollars per pikul †)

For the Week Ending	Klang	Kuala Langat
	$	$
6-4-57	137.00	148.00
13-4-57	136.00	148.00
20-4-57	135.00	146.00
27-4-57	130.00	139.00
4-5-57	130.00	138.00
11-5-57	132.00	135.00
18-5-57	132.00	135.00
25-5-57	135.00	137.00
1-6-57	136.00	137.00
8-6-57	132.00	132.00
15-6-57	128.00	127.00
22-6-57	132.00	130.00
29-6-57	130.00	130.00

* These are not the prices paid to smallholders, who sell freshly harvested berries to dealers for processing.

† 1 pikul = 133⅓ lb.

Table V

PRODUCTION OF PALM OIL AND KERNELS AND PRICES OF PALM OIL

(long tons, as declared by estates)

Month	Production of Palm Oil (long tons)		Production of Palm Kernels (long tons)		Average Price per Ton of Palm Oil *
	1956	1957	1956	1957	1957
					£ s. d.
January -	3,712	3,527	1,038	921	90 10 0
February -	3,697	3,572	1,013	926	91 16 9
March -	4,520	4,828	1,229	1,225	91 15 0
April -	4,105	4,585	1,069	1,168	89 16 7
May -	4,364	4,689	1,096	1,096	86 15 0
June -	5,263	5,140	1,310	1,203	86 14 4
July -	4,977	5,823	1,210	1,480	85 0 0
August -	5,303	5,355	1,383	1,445	82 19 0
September -	5,098		1,285		82 2 0
October -	5,387		1,411		82 7 0
November -	4,842		1,233		
December -	4,654		1,208		
Total -	55,922		14,495		

* F.O.B. London.

Table VI

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE
FEDERATION OF MALAYA

(tons)

Month	Copra Production						Coconut Oil Production *		Copra Cake (Poonac) Manufactured	
	Estates		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957
January	2,728	2,473	7,808	8,454	10,536	10,927	8,247	8,272	5,197	5,160
February	2,713	2,339	8,457	5,916	11,170	8,255	7,369	7,919	4,612	4,803
March	3,032	2,725	6,463	5,510	9,495	8,235	8,459	8,677	5,242	5,340
April	2,878	2,849	7,188	6,975	10,066	9,824	7,916	6,618	4,855	4,245
May	2,813	3,098	11,015	8,185	13,828	11,283	8,729	6,614	5,434	4,163
June	3,133	3,513	9,457	7,235	12,590	10,748	9,193	8,541	5,731	5,405
July	3.860	4.105	10,971	10,456	14,831	14,561	9,410	8,879	5,849	5,649
August	4,140	3,488	14,000	10,865	18,140	14,353	11,447	8,775	7,132	5,528
September	3,986		12,896		16,882		9,567		6,028	
October	3,807		10,605		14,412		9,403		6,263	
November	2,992		8,291		11,283		9,195		5,739	
December	2,927		7,804		10,821		9,438		5,726	
Total	39,009		115,045		154,054		108,373		67,808	

Notes:—1. The above table has been compiled fram statistics published by the Chief Statistician, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills, respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

* Includes both refined and crude oil.

Table VII

SINGAPORE PRICES OF VARIOUS AGRICULTURAL PRODUCTS
(dollars per pikul †)

Date	Copra, Sundried	Coconut Oil *	Pepper, F.A.Q. Muntok White	Pepper, Gen. Muntok White	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
1-4-57	28.625	47.25	97.00	107.00	66.00	11.50	16.50	13.00
8-4-57	26.75	46.00	101.00	111.00	66.00	11.50	16.00	13.50
15-4-57	25.50	43.50	104.00	114.00	66.00	11.25	16.00	13.50
23-4-57	26.50	44.50	105.50	115.50	66.00	11.25	16.50	13.50
29-4-57	26.25	73.75	108.00	118.00	66.00	11.00	16.00	13.50
6-5-57	26.25	44.25	104.00	114.00	66.00	11.00	15.75	13.00
13-5-57	26.05	44.05	105.00	115.00	66.00	11.00	15.75	13.00
20-5-57	26.75	45.50	108.00	118.00	66.00	10.75	15.75	13.00
27-6-57	28.00	45.50	105.00	115.00	66.00	10.75	15.75	13.00
3-6-57	27.50	45.05	108.00	118.00	66.00	10.75	15.75	13.00
10-6-57	26.87½	45.25	116.00	126.00	66.00	10.25	15.75	13.00
17-6-57	25.50	45.50	113.00	123.00	66.00	10.25	15.75	13.00
24-6-57	27.50	45.25	109.00	119.00	66.00	10.12½	15.75	12.50

† 1 pikul = 133⅓ lb.

* F.O.B. in second-hand drums.

‡ Nominal.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

Table VIII

MALAYAN AGRICULTURAL EXPORTS, JANUARY TO JUNE, 1957

Product	Net Exports in Tons			Value of Net Exports, C.I.F. ($) Jan.-June, 1957
	Year 1955	Year 1956	Jan.-June, 1957	
Arecanuts	13,679	11,228	7,970	7,748,000
Coconuts, fresh †	72,140	34,779	19,530	365,560
Coconut oil	91,176	103,132	45,372	33,965,290
Copra	75,076 *	82,549 *	33,570 *	3,119,560 *
Copra cake	56,404 *	66,174 *	40,380 *	6,529,540 *
Gambier, all kinds	66	96	130	435,400
Palm Oil	52,832	55,252	24,985	19,476,800
Pineapples, canned	27,756	30,377	17,735	16,135,000
Sago, flour	23,053	21,483	10,945	2,301,700
Sago, pearl	5,483	4,276	1,970	542,470
Sago, raw	18,709 *	18,522 *	8,035 *	507,330 *
Tapioca, flake	475	260	265	109,720
Tapioca, flour	3,979 *	3,753 *	1,386 *	382,770 *
Tapioca, pearl	5,470	5,630	3,544	1,082,830

† hundreds in number. * net imports.

METEOROLOGICAL SUMMARY, MALAYA, JULY, 1957

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of		Means of A and B	Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.		Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	° F	° F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	92.4	72.7	82.5	96.7	68.7	85.8	77.2			6.27	159.3	1.05	16	15	4			214.85	6.93	
Kuala Lumpur, Selangor	90.5	72.8	81.7	94.9	69.0	82.1	74.8			5.43	137.9	1.66	12	9	4			193.30	6.23	
Sitiawan, Perak	90.5	72.5	81.5	94.2	69.2	82.4	74.9	84.9	86.2	3.20	81.3	1.04	10	10	1			209.35	6.75	
Kuantan, Pahang	88.9	72.5	80.7	92.6	70.0	81.3	74.9			3.77	95.8	0.81	14	11	9	4		165.70	5.35	
Bayan Lepas, Penang	87.9	74.3	81.1	92.0	72.5	82.4	78.7			10.96	278.4	2.81	17	13	3			191.75	6.19	
Malacca	87.3	73.0	79.9	90.0	70.5	81.0	76.0			6.13	155.7	1.42	14	11	8	2		191.35	6.17	
Mersing, Johore	87.6	71.8	79.7	90.9	69.8	81.0	73.4			6.17	156.7	1.92	12	12				196.15	6.33	
Alor Star, Kedah	88.1	74.2	81.1	93.5	71.6	77.8	76.4			20.14	511.6	3.97	19	17	4			178.20	5.75	
Kota Bharu, Kelantan	89.0	74.5	81.7	92.2	70.1	84.5	77.5	86.1	86.8	7.42	188.5	1.76	13	9	6	1		199.50	6.43	
K. Trengganu, Trengganu	88.3	73.7	81.0	91.2	71.0	81.8	76.2			5.15	130.8	1.61	12	9				192.50	6.21	
Singapore	88.3	74.5	81.4	92.1	71.2	80.8	77.2			9.10	231.1	1.76	16	13	11		1	179.45	5.79	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.1	56.1	—	77.9	49.8	69.4	62.4			5.88	149.4	1.27	14	13				149.60	4.83	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, AUGUST, 1957

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of		Means of A and B	Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.		Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	° F	° F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	92.5	73.3	82.9	96.8	69.2	87.8	76.8	19.2	48.8	1.92	48.8	1.00	9	6	1		4	199.10	6.42	
Kuala Lumpur, Selangor	89.9	73.1	81.5	94.2	69.8	84.1	76.0	48.4	122.9	4.89	122.9	1.72	17	12	3	1		193.75	6.25	
Sitiawan, Perak	89.1	72.8	—	92.1	69.6	85.9	75.6	84.3	85.5	3.19	81.0	0.77	14		1			193.95	6.26	
Kuantan, Pahang	88.7	71.9	80.3	92.5	69.6	79.5	74.9			6.24	158.5	1.39	16	12	9	1		184.75	5.96	
Bayan Lepas, Penang	86.9	74.3	80.6	89.6	72.3	80.2	77.0			7.42	188.5	1.88	20	18	3			165.30	5.33	
Malacca	86.7	73.2	79.9	90.2	70.3	82.2	75.8			5.01	127.3	1.45	15	11	2			179.65	5.79	
Mersing, Johore	86.7	71.2	78.9	90.8	69.1	78.9	74.6			4.36	110.7	0.59	17	14			4	179.10	5.78	
Alor Star, Kedah	89.1	74.8	81.9	92.4	71.0	83.0	78.4			3.49	88.6	0.66	17	12	1			201.85	6.51	
Kota Bharu, Kelantan	84.3	74.0	81.7	94.0	70.2	83.6	77.2	86.4	87.3	5.09	129.3	0.95	13	13	3			215.40	6.95	
K. Trengganu, Trengganu	88.2	73.2	80.7	90.5	70.5	84.4	76.0			7.23	183.6	3.65	16	12				193.40	6.24	
Singapore	86.7	74.4	80.5	91.0	71.0	77.9	79.4			5.03	127.8	1.58	18	15	3			158.35	5.10	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.2	56.8	65.0	76.1	51.1	68.5	61.0			2.86	72.6	0.63	12	11				136.80	4.41	

Compiled from returns supplied by the Malayan Meteorological Service.

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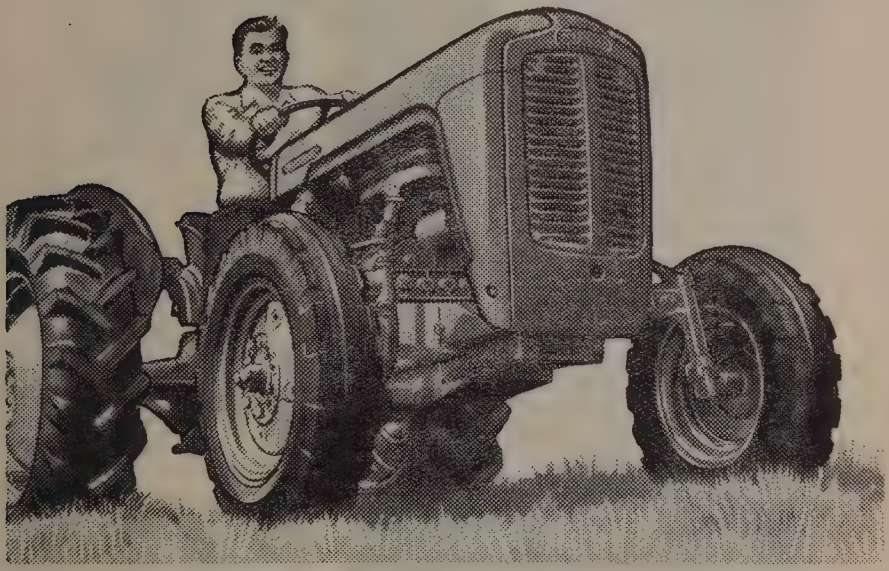

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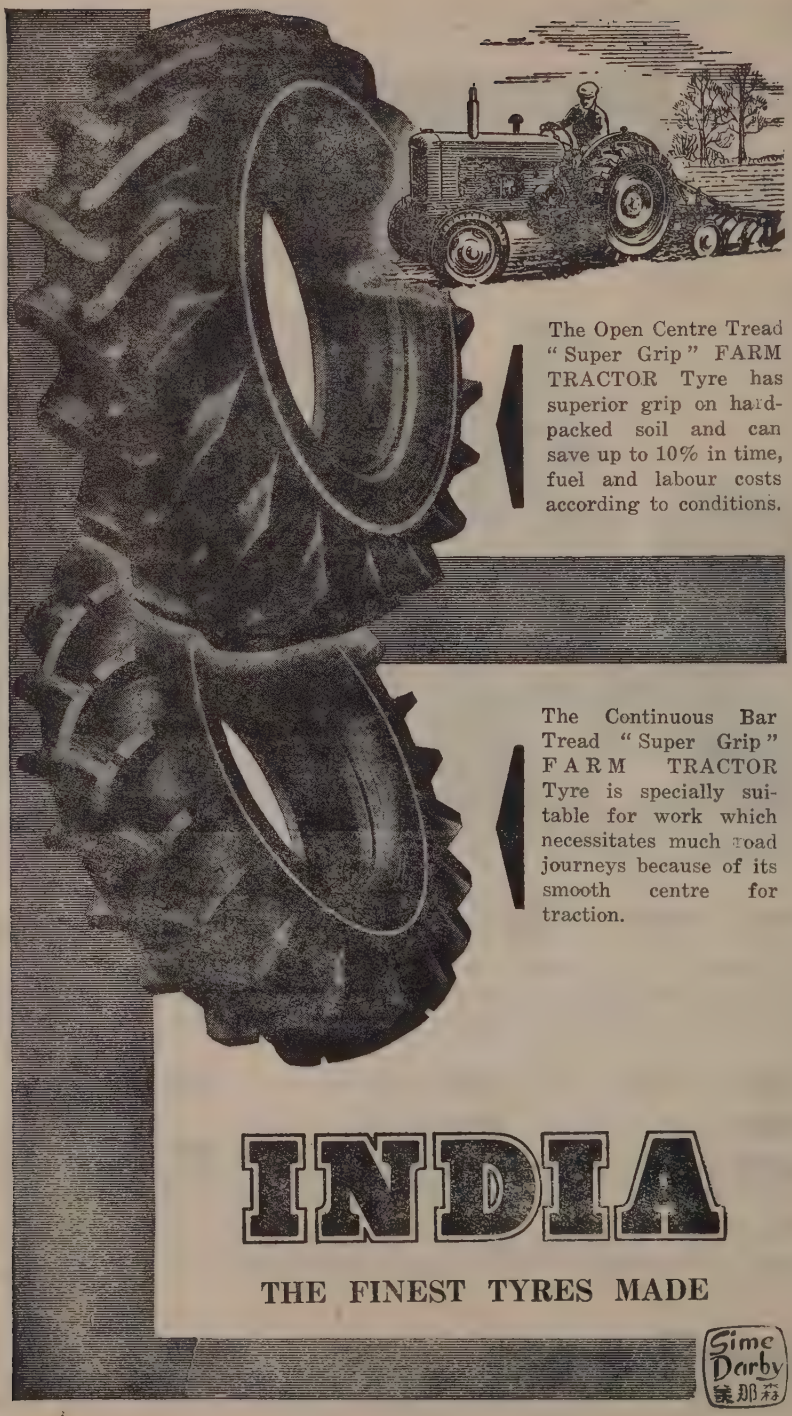

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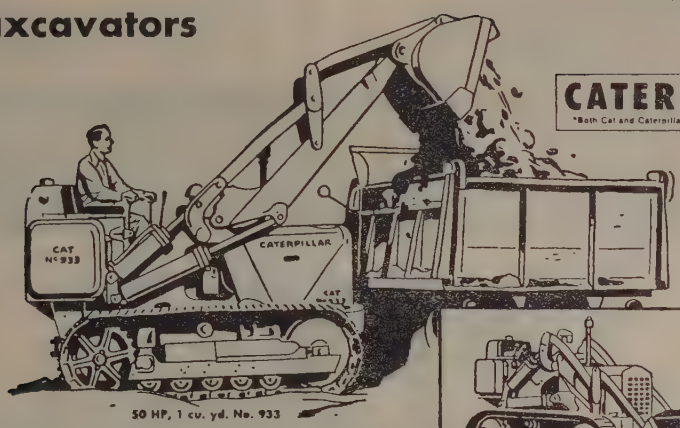

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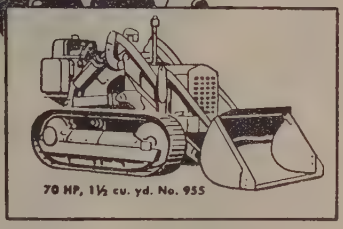

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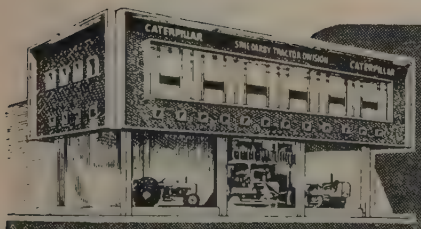

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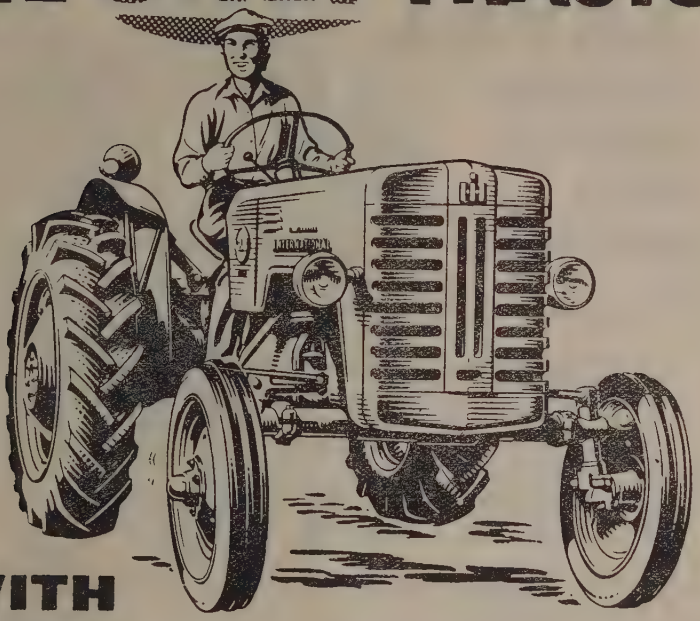

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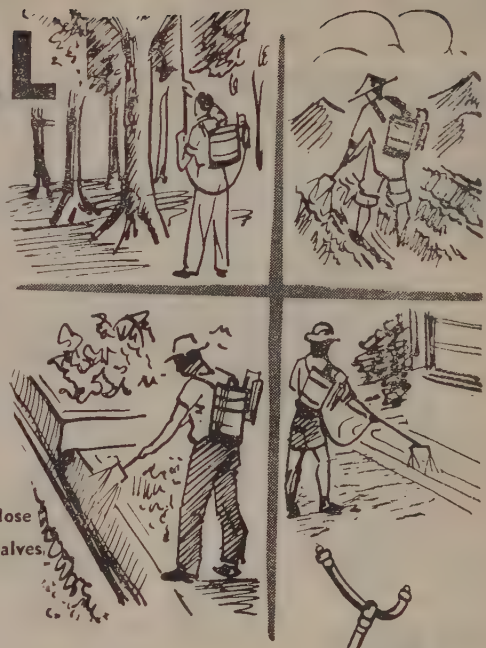

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